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NATURAL AND ARTIFICIAL HYBRIDIZATION OF GRASS SPECIES AND GENERA.*

BY

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Leipzig, Germany.

[Translator : G. M. ROSEVEARE.]

As the Gramineae in the wider sense represent, from the economic aspect, a very important plant family, it is only natural that more attention should have been devoted to it than to other families of the plant kingdom. The breeding of grasses in the narrower sense, certainly, is of recent date. A considerable amount of work has already been accomplished in respect to several species and remains yet to be accomplished in the case of other species. In the botanical study of natural hybrids no consideration has been given to environmental conditions in their influence upon plant characters, to the deviation of forms from their normal condition in consequence of the influence of particular environmental factors (G. Turesson, 1922–25, R. G. Stapledon, 1924, F. E. Clements, 1925–26, L. Cockayne and H. H. Allan, 1934).

The hybridization of grass species in wild stands untouched by man is more widely distributed than is generally assumed. But hybrid origin cannot always be proved with certainty in the case of wild plants. Many botanists, indeed, have denied the existence of hybrids (C. B. Clarke, 1891). The older school (as for example Ascherson and Graebner, 1902, L. Diels, 1920) deduced the existence of hybrid plants on the one hand from the lack of seed-setting or the poor development of seeds and pollen sterility, and on the other hand from certain more or less intermediate characters. The characters of the hybrids in the view of this school often bear a degenerate or monstrous character. L. Cockayne (1923) defined an intermediate position of characters from the parents or the occurrence of a series of forms intermediate between the parents as indicative of hybrids. The plants assumed to be the parents and their hybrids generally grow in the immediate neighbourhood of one another. The hybrid, in so far as it is fertile, has a more or less polymorphous progeny. Back-crossings with the parent forms are not out of the question. The influence of one parent may often be so dominant in simple hybrids that the other parent can only with difficulty be determined. Errors in the identification of hybrids were inevitable, and thus many a " hybrid " has become transformed on closer investigation into a variety of a grass species. The necessity for the most careful investigation of anomalous forms which are regarded as grass hybrids is thus clear. The study of wild hybrids leads naturally to consideration of the geographical distribution of the species from which the hybrid comes, and the conditions which favour or inhibit the distribution of the individual species. Here it is not possible to disregard human influence. By the transferring and replanting of species in other geographical regions or among other plant associations fresh conditions are created.

* This article has been taken, with permission of the Editors, from the periodical " Der Forschungsdienst," a leading central organ in Germany for reporting scientific work, published by J. Neumann, Neudamm and Berlin, 1. 655–84. 1936.

As a result of incorporation in other plant associations the hybrid may have originated some considerable time ago. Under some circumstances the parent species need no longer be represented at all in the locality [e.g. : *Festuca pratensis* Huds. × *Lolium perenne* L. in England (T. J. Jenkin, 1933)]. Plant associations which are rich in species offer relatively greater possibilities of hybridization than associations poor in species. Further possibilities of hybridization exist between species which are more or less widely distributed under more or less different ecological conditions, but which only meet accidentally [for example *Festuca arundinacea* Schr. × *Festuca gigantea* Vill. (T. J. Jenkin) ; *Poa arachnifera* Torrey × *Poa pratensis* L. (B. T. Galloway ; A. S. Hitchcock)]. Only those species can produce hybrids which exhibit a certain relationship to one another. It is easier for interspecific hybridization to take place among the grasses, more difficult on the other hand for intergeneric hybridization to occur.

The natural hybrids to be considered here have arisen from species of the genera *Agropyrum* Gaertner, *Agrostis* L., *Alopecurus* L., *Bromus* L., *Dactylis* L., *Festuca* L., *Glyceria* Brown, *Lolium* L., *Melica* L., *Phalaris* L., *Phleum* L., *Poa* L. ; genus hybrids, produced naturally, are known to arise from the genera *Agrostis* L., *Festuca* L., *Glyceria* Br., and *Lolium* L. The hybrids of unrelated species, so far as they occur at all, are as a rule completely or almost sterile. The easier or more difficult crossing and the fertility of the hybrids serve as a measure of relationship and systematic alliance (according to v. Tschermak, 1914). There are, however, several exceptions (cf. E. Schiemann's " Origin of some cultivated plants," 1932). In the table on " Natural hybrids of grass species " (Table 1) the species which have hitherto hybridized (the female parent being given first) are listed, together with a note of the sterility or fertility of the hybrids (in so far as communicated by the botanists), the name of the author, the year of the first and of subsequent records of the hybrid, as well as the localities in various countries in which it has been found. The oldest known and described hybrid is *Festuca pratensis* Huds. × *Lolium perenne* L., which deserves special consideration on account of its character as a genus hybrid. Fresh records of hybridizations have been made up to quite recently as the result of a closer study of wild grass stands and a more exact limitation of the conception of a hybrid, and not least of all through a study of artificially produced hybrids.

In the case of natural hybrids several degrees of fertility may be distinguished. To the entirely sterile hybrids belong, as far as they have been systematically examined, the hybrids with the following numbers (see Table 1) 17, 35, 36, 37, 38, 41, 47, 48, 59 (! ?), 73, to hybrids with fertility considerably reduced Nos. 23, 46, 72. Hybrid No. 57 has been regarded as having reduced fertility. On the fertility of other natural hybrids no information is available.

It was reserved for artificial hybridization to produce more exact information concerning the hybrids and to furnish an exact morphological and physiological description together with, as far as was possible, an exposition of the genetical and cytological relations of the hybrids and of the parents. Artificial hybridization was able to produce combinations which had not yet been discovered under natural conditions, such as the combinations Nos. 3, 4, 5, 6, 7, 8, 9, 10, 15, 16, 17, 20, 23, 24, 26, 30, 31, 34, 35, 36, 37, 38, 42, 43, 45, 47, 49, 50, 51, 52, 53, 54, 55, 56, 57, 59, 60, 62, 64 (see Table 2). As a rule the genera *Phalaris* L., *Phleum* L., *Alopecurus* L., *Avena* L., *Dactylis* L., *Cynosurus* L., *Poa* L., *Glyceria* Brown, *Festuca* L., *Bromus* L., *Lolium* L. have been employed in hybridization experiments which have been carried out in all parts of the world, partly for the obtaining of crop plants of economic importance, and partly for the elucidation of questions of a genetic and phylogenetic nature. The results of the crosses are often very contradictory. They throw some light upon the relationship of the grass species and allot a few species to a different position in the natural system than that occupied previously. Not all have been successful. The F_1 generation exhibits all transitions from complete sterility to normal fertility. No seed-setting took place in the following crosses : Nos. 3, 8, 16,

22, 35, 40, 49, 50, 52, 59, and 64 (Table 2). The causes of failure and of sterility in the hybridization of closely related species have not been clearly established. So far as genus hybrids are concerned, the incompatibility is to be attributed to the position of the parents in the natural system. In hybridization between grass species of the same genus other reasons must lead to lack of success, provided that all the experimental conditions have been optimal. Physiological correspondence between the species seems to be of great importance in order that union be obtained (Jenkin, 1933). Success is certainly very greatly dependent upon the varieties, types, or even strains employed, as has been determined in the case of other cultivated plants by W. O. Backhouse, 1916, W. B. Thompson, 1926, N. Meister and N. A. Tjumjakoff, 1928, D. Kostoff, 1930, L. Hollingshead, 1932, and as experiments at Aberystwyth and at Zerrehne, Pomerania,* prove at the present day. In Jenkin's view, supported by his extensive experiments conducted in Great Britain over a period of many years, the best result is to be obtained when the species with the lower number of chromosomes is used as the female parent. Exceptions, however, occur. Perceptible differences are seen, even when species with the same number of chromosomes are hybridized, in the form of the caryopses. When reciprocal crossing was carried out between two diploid species, for example, seeds were obtained which differ from type considerably. In general it may be said that the development of the caryopses depends mostly upon the direction of hybridization. At Aberystwyth in 1922 no germinable seeds were obtained from the cross *Lolium perenne* L. × *Festuca pratensis* Huds. (first described as a natural hybrid by Curtis in 1777). The same was the case at Hohenheim, where Knoll obtained a seed-setting of 11·3 per cent poor seeds (from 123 flowers 14 seeds). Of 273 pollinated flowers 10·6 per cent set seed at Aberystwyth. Five seeds germinated, but only one plant remained alive to be propagated by vegetative reproduction. The pollen of the hybrid was sterile. In experiments repeated later (1928–31) 726 and 1,482 emasculated flowers of *Lolium perenne* produced a single sickly plant, which died. At Zerrehne in 1931 in different strains 99 flowers produced one seed, 79 flowers 61 seeds (! !), and 53 flowers 8 seeds, while 93 flowers exhibited no seed-setting whatever. There is no information concerning germinability. In carrying out the reciprocal cross in England, seed-setting was lower in the earlier trials than in the reverse cross, but germinability was somewhat higher. From 62 *Festuca pratensis* flowers 41 full seeds (= 66 per cent) were obtained, 18 of which germinated. Only 7 plantlets, four of which were very weak individuals, survived. All the plants which reached the flowering stage exhibited pollen sterility. In further trials there were obtained from 1,382 emasculated flowers of *Festuca pratensis* two germinating seeds, which produced no surviving plantlets. At Zerrehne experiments produced a seed-setting of 50 per cent in the case of 102 flowers, in the case of 269 other flowers a seed-setting of 23 per cent. Knoll obtained in 1926 at Hohenheim a seed-setting of 14·3 per cent (from 300 pollinated flowers 43 seeds) ; there was, however, no germination. In the results just described there are contrasts with other crosses, as for instance, in the position on one side of *Lolium perenne* L. × *Festuca pratensis* Huds., and on the other side of *Lolium perenne* L. × *Festuca arundinacea* Schr. (also in the reciprocal direction). The last-named hybrid was first produced in 1893 by J. Garton, as is stated by M'Alpine ; but exact detailed information is lacking. Jenkin's hybrids of the same species (1921, 1928, 1929, 1931) gave in 1928 a seed-setting of 12·7 per cent and in 1929 of 60·5 per cent. Of the seeds, which were well-formed, 73·1 per cent germinated. From 81 seeds 75 pollen-sterile plants of the F_1 generation were produced, which grew well and the vegetative reproduction of which was easy. The reciprocal cross, *F. arundinacea* Schr. × *Lolium perenne* L., exhibited the highest seed-setting

* The results of the hybridization experiments at Zerrehne are unpublished up to the present. Herr E. Vogt, Schwiebus, has kindly given material on this subject to the author, who desires to express here his best thanks.

in 1929 with 47 per cent, the lowest in 1930 with 8·3 per cent. In 1931 E. Vogt obtained a seed-setting of 27·0 per cent. The development of the caryopses was in Jenkin's experiments better in the cross in this direction than in the reciprocal cross, but there was no germination. The successful union of *Festuca arundinacea* Schr. × *Lolium italicum* A.Br., first achieved by Garton, produced at Zerrehne 11 seeds from 38 flowers (= 28·9 per cent), the reverse cross 12 seeds from 21 flowers (= 57·1 per cent), whereas when another strain of *Festuca arundinacea* was used there was no seed-setting at all (with 16 flowers). Nothing could be learnt concerning germination. The seeds of the hybrid *Lolium perenne* L. × *Festuca ovina* L., whose development was very poor, did not germinate. In the cross *L. perenne* L. × *Festuca rubra* L. there was a considerable amount of variation in seed-setting, which was 45·4 per cent in one cross, in another 74 per cent. The development of the caryopses, which strongly resembled those of *L. perenne*, was relatively good. From 14 germinated seeds 9 plantlets were produced, which all remained alive. The F_1 plants had sterile pollen and in appearance bore a greater resemblance to *F. rubra*. In the reciprocal cross (*F. rubra* L. × *Lolium perenne* L.) seed-setting was very poor, and the development of the caryopses very deficient. There was no germination. From 181 flowers there was 7·2 per cent seed-setting (= 13 seeds). Nilsson's experiments exhibited very poor seed-setting and only produced two surviving plants. In an intergeneric cross, with *Lolium perenne* L. as the female parent and *Dactylis glomerata* L. or *Avena elatior* L. as the male parent (1921), no seed was formed in either case in spite of good pollination conditions, nor was any seed produced when *Glyceria fluitans* was pollinated by *Lolium perenne* or when *Festuca pratensis* Huds. received pollen from *Glyceria fluitans* (Vogt, 1931).

Results from the hybridization of *Festuca pratensis* Huds. × *Festuca rubra* L. and the reciprocal cross are of a peculiar nature. At Aberystwyth, in the case of the first cross very low seed-setting, 10·6 per cent, was obtained ; at Zerrehne, with *Festuca rubra* L. *eu-rubra* Hack. as the male parent, a seed-setting of 8 and 13 seeds was obtained from 98 and 111 emasculated flowers respectively. When pollen of *Festuca rubra* L. var. *genuina* Hackel was used there was obtained from 100 flowers 4 seeds, and from 273 flowers 84 seeds. There is no information on the germination obtained at the German plant breeding station. In Great Britain no germinable seed was obtained from the cross in either direction, in spite of the development of caryopses. The size of the latter varies in accordance with the direction of the cross. Their development was poorer when *Festuca rubra* L. was the female parent. According to Jenkin both the 42-chromosome type and the 56-chromosome type of *Festuca rubra* can produce seed-setting if *F. rubra* is used as the male parent. The best developed caryopses were obtained when the stigmas of the species with the lower number of chromosomes were pollinated. In regard to the number of chromosomes this cross may be compared with the cross *Lolium perenne* L. × *Festuca rubra* L. In no case is the degree of development of the caryopsis an indication of germinability, as F. Nilsson also has found. Seed-setting in the case of the hybrid *Festuca pratensis* Huds. × *Festuca rubra* L. amounted to 10·6 per cent of 679 flowers, in the reciprocal cross 12·3 per cent of 432 flowers. In the cross *Festuca pratensis* Huds. × *Festuca arundinacea* Schr. seed-setting from 32·4 to 94·6 per cent was obtained in 1924 and 1928. From 235 emasculated flowers Jenkin obtained 34 plants (=14.5 per cent). In this direction fertility was good. In the reciprocal cross the results are not very different. The development of the caryopses is less complete. The highest seed-setting was 67·6 or 94·6 per cent. The F_1 plants exhibited no clear distinctions in accordance with the direction with which the cross was made, either in morphological characters or in vigour. Both crosses gave an F_1 generation with infertile pollen. Similar crosses made by E. Vogt at Zerrehne in 1931 did not produce so high a degree of seed-setting as in Wales. From 283 and 85 flowers in the case of the first hybrid 64 and 7 seeds respectively were formed (23 and 8 per cent), in the case of the second cross 72 seeds from 344 flowers (= 21 per cent). These relatively low

figures are remarkable, especially as at Zerrehne also the development of the caryopses left much to be desired. Different behaviour was exhibited by the hybrid *Festuca pratensis* Huds. × *Festuca gigantea* Vill. Jenkin obtained a seed-setting of 60·9 per cent from 46 flowers and poor development of the caryopses with a germinability of 34·8 per cent. The F_1 plants were vigorously developed, but produced no effective pollen. This cross (1930), which was carried out (in the opposite direction only) by Vogt in 1931, who obtained 56 seeds from 374 flowers, was not so successful as Jenkin's cross of *Festuca gigantea* Vill. × *Festuca arundinacea* Schr. in the same year, wherein 74 per cent of the emasculated flowers produced seed to a total of 77. A germinability of 89·5 per cent was determined and 51 plants of the F_1 generation were grown further. The number of chromosomes in the two parent species is the same, a fact which accounts for the success of the reciprocal cross. F. Nilsson also carried out the reciprocal cross successfully and obtained several seeds, from which two plants were produced. The F_1 hybrids of the crosses in the two directions are very little different morphologically, nor is there much difference in the development of the caryopses or in germination. The lack of resemblance in the growth habit of the parents is noticeable. The vigorous F_1 plants bore no fertile pollen. In the hybridization of *Festuca arundinacea* Schr. × *Festuca rubra* L., the occurrence of which has not yet been observed in wild stands, a low percentage of seed-setting (8·2 per cent from 273 flowers) was obtained. In spite of well-developed caryopses in some crosses no germination resulted. In correspondence with these findings are the results obtained by E. Vogt, who used a variety, *Festuca rubra* L. var. *genuina* Hack., as the male parent and from 60 flowers of *Festuca arundinacea* obtained 5 seeds (= 8·3 per cent), which did not germinate. When he used *Festuca rubra* L. *eu-rubra* Hack., he obtained no seed-setting in 59 flowers. Different behaviour was exhibited in the reciprocal cross (*Festuca rubra* L. × *Festuca arundinacea* Schr.). Seed-setting in this direction was higher, in 1928, according to Jenkin, 11·8 per cent, and it rose to 60 per cent in another cross. The development of the caryopses was poorer, and germination left somewhat to be desired. Of a total of 91 seeds 7, that is to say, 7·7 per cent, germinated. The seven resulting plants were very weak. Although they survived, only one lived through the winter, which, however, formed no inflorescence. The simple and reciprocal cross of *Festuca rubra* L. var. *genuina* Hack. × *Festuca ovina* L. produced similar results as in the case of the hybridized *Festuca arundinacea* Schr. and *Festuca rubra* L. The germination of the caryopses (3 seeds were obtained from 132 flowers = 2·3 per cent) failed in the cross *Festuca rubra* L. × *Festuca ovina* L.; in the case of the reciprocal cross, however, it was 42·9 per cent. Of 7 seeds 3 germinated, producing 2 plants, both of which grew normally and plainly showed the influence of the male parent (*Festuca rubra* L.).

The results obtained in the combination of *Lolium italicum* A.Br. × *Festuca pratensis* Huds. at Zerrehne were remarkable in regard to seed-setting. Here also, using as the male parent plants differing from one another was noted to have an effect. In the first case a seed-setting of 46 per cent was obtained from 156 flowers, in the second case it was only 1 per cent from 111 flowers. In contrast to the Zerrehne results are those obtained by Knoll, who obtained a seed-setting of 10 per cent, the seed not germinating later (from 40 flowers 4 seeds; in the reciprocal cross, according to Knoll, 2 per cent seed-setting from 100 pollinated flowers). Similar results as in this intergeneric cross can also be obtained in the crossing of species, as for example, a fluctuation of seed-setting from 9 to 56 per cent in the hybrids of *Lolium perenne* L. × *Lolium italicum* A.Br., which are generally considered to be very fertile (Garton, Boeker, Hessing, Nilsson, Rozkov, Knoll, Weller). One hundred flowers produced 9 seeds, 88 flowers 49 seeds, 102 flowers 51 seeds, and 103 flowers 30 seeds. The better seed-setting was obtained when *Lolium italicum* was used as the female parent (Knoll, Nilsson). Nilsson obtained thereby 66 full seeds, but in the reciprocal cross only 3 seeds; Knoll in the simple direction 3 seeds from 39 pollinated flowers (= 7·7 per cent), which gave one hybrid plant, in the reciprocal direction 53 seeds from 60

pollinated flowers (88·3 per cent seed-setting). All the seeds germinated and developed into healthy, vigorous plants.

Poor seed-setting is recorded in the case of species hybrids of the genus *Phalaris* L., as in the cross *Phalaris arundinacea* L. × *Phalaris canariensis* L. On the one hand Vogt obtained in 1931 14 seeds from 635 emasculated flowers, on the other hand only one seed from 272 flowers. On the contrary good seed-setting was obtained by Jenkin and Sethi in the combination of *Phalaris arundinacea* L. × *Phalaris tuberosa* L. In the reverse cross seed-setting was either poor or entirely lacking. Seed-setting in the cross *Poa nemoralis* L. × *Poa pratensis* L. was, in contrast to the case of *Phalaris* hybrids, very high, namely, 69·5 per cent (in Zerrehne 1,011 seeds were obtained from 1,454 flowers). From the hybrid *Poa pratensis* L. × *Poa annua* L. var. *reptans* Hausskn. Vogt obtained no seed-setting in spite of good pollination conditions. The hybridization of *Alopecurus* was undertaken for the first time at Zerrehne. Unfortunately, no clear picture of seed development and seed-setting can be obtained from the experiment. In hybridizing *Alopecurus pratensis* L. × *Alopecurus fulvus* L. there were obtained in one case 10 seeds from 663 emasculated flowers (1.5 per cent), on the other hand 266 seeds from 773 flowers (= 34·4 per cent). The reciprocal cross, *Alopecurus fulvus* L. × *Alopecurus pratensis* L., produced only 12 seeds from 894 flowers (1·3 per cent). On using the variety *nigricans* Sonder of the species *Alopecurus pratensis* L. there was a complete lack of seed-setting in the cross *Alopecurus pratensis* L. var. *nigricans* Sonder × *Alopecurus fulvus* L., whilst a seed-setting of 17 from 123 flowers (= 13·8 per cent) was obtained when the above-mentioned variety was used as the female parent and *Alopecurus pratensis* L. as the male parent.

The hybridized *Avena* species *Avena elatior* L. × *Avena pubescens* Huds. gave in three out of four cases no seed (pollination of 41, 43, and 62 flowers respectively). In an exceptional case 112 flowers on emasculation gave one seed (seed-setting = 0·9 per cent). The reciprocal cross *Avena pubescens* Huds. × *Avena elatior* L. set 5 seeds from 784 emasculated flowers (= 0·6 per cent seed-setting), and 3 seeds from 112 flowers (= 0·2 per cent). Experiments in the hybridization of *Bromus* species, as for example *Bromus arvensis* L. × *Bromus inermis* Leysser, resulted, when carried out in a reciprocal direction, in very greatly reduced seed-setting. When the simple cross was carried out 520 seeds were formed from 750 flowers (= 69·3 per cent), in the reverse direction only one seed from 458 flowers (0·21 per cent). No result was obtained from the union *Bromus secalinus* L. × *Bromus arvensis* L., although it is a case of the hybridization of closely related species. A generic cross, *Cynosurus cristatus* L. × *Dactylis glomerata* L., was, according to Vogt, successful, and produced an average of 14·8 per cent well-developed seeds. There is no information as to the germinability of the seed.

In estimating the economic value of artificially produced hybrids it should first of all be considered whether several desired characters are discernible in the hybrid, which is not necessarily the case always. The endowment of one species with individual characters from another often offers difficulties which cannot be overlooked, because under certain circumstances undesirable characters may easily be carried on from a parent form into the hybrid. What may be attained from suitable and successful interspecific hybridization is seen, for example, in *Lolium* species such as the so-called " Oldenburg ryegrass " (hybrid : *Lolium perenne* × *Lolium italicum* A.Br. ; and reciprocally) and the Australian " Wimmera ryegrass " (hybrid : *Lolium italicum* A.Br. × *Lolium rigidum* Gaud. ; *L. perenne* A.Br. × *Lolium rigidum* Gaud.), further in the artificial production of the hybrid *Spartina Townsendii* H. and J. Groves (emanating from *Spartina maritima* (Curt.) Fernald and *Spartina alterniflora* Loisel) and, in order to give a similar example from the family of the Leguminosae, the well-known combination of *Medicago sativa* L. and *Medicago falcata* L., which has resulted in a great transformation in the forage crop production of the most widely varied countries (e.g. Germany, the U.S.A., and others).

For practical agricultural purposes in the case of the grasses, the attempt, for instance, to cross *Avena flavescens* L. and *Arrhenatherum elatior* M. et Koch. might be valuable. In the combination of these *Avena* species with good characters it might perhaps be possible to extend the eastern limit of the cultivation of *Avena flavescens* L. in Germany, which now follows the course of the river Elbe in a north to south direction. A combination of *Dactylis Aschersoniana* Graebner with *Dactylis glomerata* L. might perhaps modify or eliminate, through the formation of short stolons, the undesirable tuft-forming character and allow of the production of seeds which do not require stimulation through change of temperature. The cross of *Festuca pratensis* Huds. with *Festuca arundinacea* Schr. might also be desirable for the obtaining of greater competitive ability in mixed stands (deficient in *Festuca pratensis*) through the formation of taller tufts. Further endeavours might also be made to hybridize *Festuca pratensis* Huds. and *Festuca rubra* L. var. *genuina* Hack. in order to provide a creeping meadow fescue × red fescue hybrid which would exhibit a capacity for sward formation, in contrast to the one parent, and would produce high bulk yield. The hybrid *Festuca pratensis* Huds. × *Festuca gigantea* Vill. is said to be resistant to rust. In the hybrid *Lolium perenne* L. × *Lolium italicum* A.Br., already on the market, the longevity and greater winterhardiness of perennial ryegrass in the first year of development are combined with the distinguishing character of Italian ryegrass, heavy yield of green weight. Of importance also would be the hybridization of *Phalaris arundinacea* L. with *Phalaris bulbosa* L. for alteration of the time of flowering and ripening and for the obtaining of hybrid forms for the more arid soils. The annual *Phalaris canariensis* L. might, if hybridized with the perennial *Phalaris arundinacea* L., produce more rapidly-growing, tender-leaved hybrids with greater longevity and fruits more firmly attached to the pales when the seeds ripen. The lack in *Phalaris* species of firm seed attachment has in general been detrimental to seed harvest and the quantity of seed. Of less importance probably are the hybrids of the *Phleum* species. There should be mentioned, in addition to the combination *Phleum pratense* L. × *Phleum Michelii* Allioni, the cross *Phalaris pratensis* L. var. *medium* Brügger × *Phalaris alpinum* L., which may possibly become of importance for forage crop production in the lowland plains of northern Germany. In the *Poa* species an urgent task is the elimination of the villose character of the flowers in the hybrids, so inconvenient when the seed is cleaned, while at the same time the good characters of the parent species are retained, as for example, in *Poa pratensis* L. × *Poa alpina* L., *Poa pratensis* L. × *Poa nemoralis* L. var. *firmula* (Gaud.) S. F. Gray. The fulfilment of this task offers no considerable difficulty, as the experiments with *Poa arachnifera* Torrey × *Poa pratensis* in the United States have shown. It will suffice to mention these combinations of grass species.

The views of F. G. Stebler and C. Fruwirth in regard to the lack of necessity for hybridization and breeding by combination are not tenable. All species combinations have not yet been tried by any means, and many discrepances (for example, the success of hybridization in one direction and failure in the reciprocal direction, and success when certain forms or strains are used) await explanation. In addition to the elucidation of the complex chromosome condition of the hybrids, their morphology and fertility require closer study. Further experiments in the combination of grass species, and in certain cases of grass genera also, with special reference to agricultural utility, should be carried out in future at German plant breeding stations as a contribution to the increasing of grassland yield and to the ensuring of animal nutrition from home-grown products.

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Table 1. Natural hybrids of grass species.

Key to symbols: * Sterile. † Partly fertile. ‡ Generally sterile. § Fertile. ** Partly sterile.

Species hybridized.	Author, year, place in which the hybrid was found.
1. *Agropyrum caninum* (L.) P.B. × *Agropyrum repens* (L.) P.B. Also reciprocally.	Andersen 1931 : 1926 near Vester Skerninge on the Island of Fünen, Denmark.
2. *Agropyrum cristatum* J. Gaertn. × *Agropyrum repens* (L.) P.B. Also reciprocally.	
3. *Agropyrum repens* (L.) P.B. × *Hordeum nodosum* L.	P. Nielsen 1860 : Denmark. R. Vestergren 1925 : Sweden. S. Andersen 1931 : Sjaelland, Denmark.
4. *Agrostis alba* L. × *Agrostis alpina* Scopoli.	Brügger 1868 : Graubünden, Switzerland. Ascherson and Graebner.
5. *Agrostis alba* L. × *Agrostis rupestris* All.	Ascherson and Graebner 1902.
6. *Agrostis alba* L. × *Agrostis vulgaris* With.	
7. *Agrostis alba* L. × *Calamagrostis tenella* Lk. (Genus hybrid.) Also reciprocally.	Stebler and Schröter 1898 : Graubünden, Switzerland.
8. *Agrostis alpina* Scop. × *Agrostis rupestris* All. = *A. Hegetschweileri* Brügger.	Brügger 1850, 1882 : Upper Engadin, Switzerland.
9. *Agrostis canina* L. × *Agrostis stolonifera* E.M.	Andersen 1929 : Veyle, Denmark ; 1931 : Sweden, Finland.
10. *Agrostis canina* L. × *Agrostis tenuis.*	Andersen 1926 : Logeskov ; 1931 : Langeland, Denmark ; 1931 : Sweden, Norway.
11. *Agrostis stolonifera* E.M. × *Agrostis tenuis.*	Andersen 1931 : Sweden, Norway, Russia, Finland.
12. *Agrostis vulgaris* With. × *Agrostis canina* L. 1. *Agrostis Sanionis* ; 2. *Agrostis Mercieri.*	Sanio 1886 : Lyck, East Prussia. Mercier 1860 : Canton Waadt, Switzerland.
13. *Alopecurus arundinaceus* Poir. × *Alopecurus pratensis* L.	Schmalhausen : Narwa, Russia.
14. *Alopecurus fulvus* L. × *Alopecurus geniculatus* L.	Andersen 1926 : Copenhagen. K. Fritsch 1922 : Austria. Andersen 1931 : Sweden, Norway.
15. *Alopecurus fulvus* L. × *Alopecurus pratensis* L. = *A. hybridus* Wimmer.	K. Fritsch 1922 : Austria. Andersen 1931 : Sweden.
16. *Alopecurus geniculatus* L. × *Alopecurus fulvus* L. = *A. Haussknechtianus* A. et Gr.	Haussknecht 1882 : Bremen, West Prussia, Thuringia, Austrian Silesia. Ascherson and Graebner 1898.

TABLE 1—*continued.*

Species hybridized.	Author, year, place in which the hybrid was found.
*17. *Alopecurus geniculatus* L. × *Alopecurus pratensis* L.	Wichura 1865 : Silesia. Schmalhausen : Petersburg. Hallier : Heligoland. O. Kuntze 1867 : Leipzig. Focke 1881 : Leipzig, Bremen, Brückenau. Haussknecht 1882 : Bremen, Jena, Saalfeld. Heidenreich : Tilsit, East Prussia. Gerhard and Figert 1886 : Liegnitz, Silesia. Galicia : Lemberg. K. Fritsch 1922 : Austria. A. Nilsson 1929 : Krageholm (Scania), Sweden. Andersen 1931 : Sweden, Finland, Denmark. Botanical Garden Helsinki 1934.
18. *Alopecurus geniculatus* L. × *Alopecurus ventricosus* Pers.	Andersen 1931 : Sweden, Finland.
19. *Alopecurus myosuroides* Huds. × *Alopecurus pratensis* L. = A. *Turicensis* Brügger.	Brügger 1866 : Zürich.
20. *Alopecurus pratensis* L. × *Alopecurus agrestis* L.	Ascherson and Graebner 1902.
21. *Alopecurus pratensis* L. × *Alopecurus fulvus* L. = *A. Winklerianus* A. et Gr.	M. Winkler 1859 : Neisse, Silesia.
22. *Alopecurus pratensis* L. × *Alopecurus geniculatus* L.	Wichura 1865 : Silesia. Hallier : Heligoland. O. Kuntze 1867 : Leipzig. Focke 1881 : Bremen. Haussknecht 1882 : Bremen, Thuringia. Heidenreich : East Prussia. Gerhard and Figert 1886 : Silesia. Galicia. S. Andersen 1931.
†23. *Alopecurus pratensis* L. × *Alopecurus ventricosus* Pers.	Schmalhausen 1875 : Narwa, Russia. L. von Klinggräff 1905 : Stuhm, West Prussia. S. Andersen 1931 : Sweden, Finland, Russia, Denmark (northern Falster).
24. *Alopecurus ventricosus* Pers. × *Alopecurus geniculatus* L. = *A. Marssoni* Haussknecht.	Haussknecht 1888 : Pomerania, Island of Usedom. Ascherson and Graebner : Finland.
25. *Bromus arvensis* L. × *Bromus commutatus* Schrader.	O. R. Holmberg 1924 : Sweden. S. Andersen 1931 : Sweden.
26. *Bromus arvensis* L. × *Bromus racemosus* L.	O. R. Holmberg 1924 : Sweden. S. Andersen 1931 : Sweden.
27. *Bromus hordeaceus* L. × *Bromus racemosus* L.	Mejer 1875 : near Hanover. O. R. Holmberg 1924 : Sweden. S. Andersen 1931 : Sweden.
28. *Bromus racemosus* L. × *Bromus hordeaceus* L.	Mejer 1875 : near Hanover.
29. *Bromus ramosus* Huds. × *Bromus erectus* Huds.	Reichenbach 1830.
30. *Bromus secalinus* L. × *Bromus hordeaceus* L.	O. Kuntze 1867 : near Leipzig.
31. *Bromus sterilis* L. × *Bromus tectorum* L.	O. Kuntze 1867 : near Leipzig.

TABLE 1—*continued.*

Species hybridized.	Author, year, place in which the hybrid was found
32. *Calamagrostis tenella* Link × *Agrostis alba* L. = *Agrostis Stebleri* Schröter. (Genus hybrid.)	Stebler and Schröter 1898 : Fürstenalp near Chur, Switzerland.
33. *Dactylis Aschersoniana* Gr. × *Dactylis glomerata* L.	O. R. Holmberg 1923 : Bökeberg (Scania), Sweden. S. Andersen 1931 : Sweden, Denmark (Seeland, Dyrehaven according to Turesson). Botanical Garden Helsinki 1934.
34. *Dactylis glomerata* L. × *Dactylis Aschersoniana* Gr.	S. Andersen 1931. N. Sylvén 1934 : Sweden.
*35. *Festuca arundinacea* Schreber × *Festuca gigantea* Vill. = *Festuca Fleischeri* Rohlena.	K. Fritsch 1922 : Austria. S. Andersen 1931 : Sweden, Denmark (Seeland, Sondersoen, Falster, Nykobing 1929). N. Sylvén 1934 : Scania, Sweden. F. Nilsson 1935 : Scania.
*36. (*Festuca arundinacea* Schr. × *Festuca gigantea* Vill.) × *Festuca pratensis* Huds.	F. Nilsson 1935 : Scania.
*37. *Festuca arundinacea* Schr. × *Festuca pratensis* Huds.	F. Curtis 1789 (" *Festuca elatior* "). G. Sinclair 1816 (" *Festuca elatior* var. *sterilis* "). Aschersson and Graebner 1902 : Serbia, South Russia. Levitsky and Kuzmina 1926 : Kiew. A. Nilsson 1929 : Landskrona, Sweden. S. Andersen : Sweden, Norway ; Denmark : near Moen. Stege (Holmberg). 1929 near Ullerslev, near Stenlose.
*38. *Festuca arundinacea* Schr. × *Lolium multiflorum* Lam. (Genus hybrid.)	Krasan 1898 : Graz. Andersen 1928 : near Aalborg. Holmberg 1930.
39. *Festuca arundinacea* Schr. × *Lolium perenne* L. (Genus hybrid.)	Holmberg 1926. A. Nilsson 1929 : Lomma, Landskrona, Hildesborg, Sweden. Andersen 1931 : Sweden.
40. *Festuca gigantea* Vill. × *Festuca* (*elatior*) *pratensis* Huds.	Holmberg 1930. Andersen 1931 : Sweden, Denmark (Seeland, Sandersoen). Radeloff 1930.
*41. *Festuca gigantea* Vill. × *Lolium perenne* L. = *Festulolium Brinkmanni* A. Br. (Genus hybrid.)	Al. Braun 1861 : Berlin (Botanical Garden). Brinkmann : Rostock. Ascherson and Graebner 1902. Holmberg 1926. Andersen 1931 : Sweden.
42. *Festuca Halleri* All. subsp. *dura* A. et Gr. × *Festuca violacea* subsp. *genuina* Hackel = *Festuca schisticola* Vetter.	J. Vetter 1923 : Austria.
43. *Festuca ovina* L. × *Festuca pseudovina* Hackel.	Hackel 1882. K. Fritsch 1922 : Austria, near Vienna.
44. *Festuca ovina* L. × *Festuca rubra* L. = *Festuca Zobelii* Wein.	Saint-Yves 1929 : France.
45. *Festuca* (*elatior*) *pratensis* Huds. × *Festuca arundinacea* Schr.	Hackel 1882. Haussknecht 1885 : Bremen, Usedom. Reuter : Col di Tenda. Ascherson and Graebner 1898. Holmberg 1930 : Sweden, Norway, Denmark. S. Andersen 1931 : Denmark. Radeloff 1930 : Botanical Garden Berlin.

TABLE 1—*continued.*

Species hybridized.	Author, year, place in which the hybrid was found.
‡46. *Festuca* (*elatior*) *pratensis* Huds. × *Festuca gigantea* Vill. = *Festuca Schlickumi* Grantzow.	Grantzow 1888 : near Prenzlau. Hackel 1882 : near Karlsbad : Haussknecht : Pomerania, Usedom, Binz (Rügen). L. Celakovsky 1886 : near Waltsch, Bohemia. H. Kofahl 1924 : Zernickow, Brandenburg. Saint-Yves 1929 : France. K. Fritsch 1922 : Austria. Holmberg 1930.
*47. *Festuca* (*elatior*) *pratensis* Huds. × *Lolium italicum* A. Br. = *Festuca loliacea* Curtis var. *aristata* A. Br. (?) (Genus hybrid.)	Brunner 1851 : Oberbaden. Mertin : near Wertheim. Mejer 1875 : near Hanover. K. Richter 1890.
*48. *Festuca* (*elatior*) *pratensis* Huds. × *Lolium perenne* L. = *Festuca loliacea* Curtis = *Festulolium ascendens* A. et Gr. (the oldest known genus hybrid).	Curtis 1777: Battersea. Retzius 1779. Swayne 1790. Ehrhart 1791. Withering 1796. Knapp 1804. A. Braun 1834. F. Schultz 1854 : Wiesenburg. Crépin 1863. Ascherson 1864. O. Kuntze 1867 : Leipzig. N. S. Scheutz 1880 : Malmö, Limhamn, Sweden. Areschoug 1881 : Björka, Helsingborg, Alnarp, Sweden. Hackel 1882. Ascherson and Graebner 1902. S. Andersen 1916 : Nördl. Jylland : Hobro. G. C. Druce 1917 : England. S. Andersen 1920 : Skelund, Abenraa. 1923 : Taasinge, Vemmenaes. Holmberg 1926 : Landskrona, Sweden. A. Nilsson 1929 : Alnarp, Krageholm, Helsingborg, Landskrona. C. E. Hubbard (Kew) 1930 : Middlesex. R. G. Stapledon 1930 : Wiltshire, England. T. E. Jenkin 1931 : Oxford. S. Andersen 1931 : Sweden, Norway, Denmark (Osten).
49. *Festuca pratensis* Huds. × *Festuca rubra* L.	Wein 1909. Saint-Yves 1929 : France.
50. *Festuca pseudovina* Hackel × *Festuca rubra* L.	K. Fritsch 1922 : Austria.
51. *Festuca rubra* L. × *Festuca gigantea* Vill. = *Festuca Haussknechtii* Torges.	Warnstorf 1873 : Altmark (Klötze). Haussknecht 1888 : Binz (Rügen). Torges 1889 : Thuringia. P. Prochno 1890.
52. *Festuca rubra* L. × *Lolium perenne* L. (Genus hybrid.)	F. Nilsson 1927 : Landskrona, Sweden.
53. *Festuca rubra* L. × *Festuca sulcata* (Hack.) Nym. × *Festuca vaginata* W.K.	K. Fritsch 1922 : Austria.
54. *Glyceria fluitans* R. Br. × *Glyceria plicata* Fries = *Glyceria intersita* Haussknecht.	Haussknecht 1885. Richter 1890. Sanio 1890. O. R. Holmberg 1904 : Sweden. G. Hegi.
55. *Glyceria fluitans* R. Br. × *Lolium perenne* L. (Genus hybrid.)	Areschoug 1881 : Christianstad, Benestad, Lund, Sweden.
56. *Lolium italicum* A. Br. × *Lolium arvense* Schrader.	Mejer 1875 : Hanover. Focke 1881.
§57. *Lolium italicum* A. Br. × *Lolium perenne* L.	Mejer 1875 : Hanover. Andersen 1924 : Aarhus Denmark. Andersen 1931 : Sweden.
*58. *Lolium italicum* A. Br. × *Festuca gigantea* Vill. (Genus hybrid.)	F. Nilsson 1930 : Sweden.

TABLE 1—*continued.*

Species hybridized.	Author, year, place in which the hybrid was found.
*59. *Lolium perenne* L. × *Lolium multiflorum* Lam. = *Lolium hybridum* Haussknecht.	Haussknecht 1881 : Weimar, Rudolstadt, Frankenhausen, Dessau. Favrat (according to Grenli,) 1883 : Lausanne. Körnicke 1890 : Bonn. H. N. Frandsen 1911 : Tystofte, Denmark. P. Boeker 1914 : Oldenburg. F. Nilsson 1926 : Landskrona, Sweden. O. R. Holmberg 1926 : Sweden. J. Knoll 1926 : Hohenheim.
60. *Lolium perenne* L. × *Lolium temulentum* L.	O. Kuntze 1867 : Leipzig.
61. *Lolium remotum* Schrank × *Lolium italicum* A. Br.	Mejer 1875 : Hanover.
62. *Melica nutans* L. × *Melica picta* K. Koch = *Melica Aschersonii* M. Schulze.	Čelakovsky 1887 : Kostomlat, Bohemia. M. Schulze 1888 : Jena. Appel 1896 : Lower Franconia. Hegi 1906 : Thuringia.
63. *Phalaris arundinacea* L. × *Phalaris tuberosa* (*bulbosa*) L.	E. Breakwell 1920 : New South Wales, Australia
64. *Phleum alpinum* L. × *Phleum Michelii* Brügger.	Brügger 1881 : Glarner Alps, Switzerland.
65. *Phleum pratense* L. × *Phleum nodosum* (L.).	A. Müntzing 1935 : Sweden.
66. *Poa alpina* L. × *Poa caesia* Sm.	K. Fritsch 1922 : South Tyrol.
67. *Poa annua* L. × *Poa pratensis* L.	Ascherson and Graebner.
68. *Poa compressa* L. × *Poa pratensis* L.	Schur 1866 : Siebenbürgen.
69. *Poa nemoralis* L. × *Poa compressa* L. = *Poa Figerti* Gerh.	Figert 1892 : Silesia. Gerhardt 1892 : Silesia.
70. *Poa nemoralis* L. × *Poa pratensis* L.	O. Kuntze 1867 : Leipzig.
71. *Poa nemoralis* L. × *Poa trivialis* L.	O. Kuntze 1867 : Leipzig.
**72. *Poa pratensis* L. × *Poa palustris* L.	S. Andersen 1931 : Copenhagen Freihafen.
*73. *Poa supina* Schrader (*Poa annua* var. *supina* Reichenbach) × *Poa annua* L.	J. A. Nannfeldt 1935 : Sweden.
74. *Poa trivialis* L. × *Poa pratensis* L. = *Poa Sanionis* A. et Gr.	Sanio 1900 : Lyck, East Prussia. Ascherson and Graebner 1900. P. Jansen and W. H. Wachter 1933 : Zuyder Zee shore, Holland.

Table 2. Artificial hybridization of grass species.

Hybrids.	*Degree of fertility or sterility.	Author, year and place in which the hybridization was carried out.
1. *Alopecurus fulvus* L. × *Alopecurus pratensis* L.	I ; I	E. Vogt 1931 : v. Kameke's Seed Breeding Station, Streckenthin, Grass Breeding Department, Zerrehne, Pomerania.
2. *Alopecurus pratensis* L. × *Alopecurus fulvus* L.	I ; II	E. Vogt 1931.
3. *Alopecurus pratensis* L. var. *nigricans* Sonder × *Alopecurus fulvus* L.	O	E. Vogt 1931.
4. *Avena elatior* L. × *Avena pubescens* Huds.	I ; O	E. Vogt 1931.
5. *Avena pubescens* Huds. × *Avena elatior* L.	I	E. Vogt 1931.
6. *Bromus arvensis* L. × *Bromus inermis* Leysser.	III	E. Vogt 1931.
7. *Bromus inermis* Leysser × *Bromus arvensis* L.	I	E. Vogt 1931.
8. *Bromus secalinus* L. × *Bromus arvensis* L.	O	E. Vogt 1931.
9. *Bromus unioloides* Humb. et Kunth × *Bromus arvensis* L.	III	E. Vogt 1931.
10. *Cynosurus cristatus* L. × *Dactylis glomerata* L.	I	E. Vogt 1931.
11. *Dactylis Aschersoniana* Gr. × *Dactylis glomerata* L.	I	H. Witte 1929 : Svalöf (Scania), Sweden ; Seed Breeding Station.
12. *Dactylis glomerata* L. × *Dactylis Aschersoniana* Gr.		A. Müntzing 1933 : Svalöf.
13. *Festuca arundinacea* Schr. × *Festuca gigantea* Vill.	I	T. J. Jenkin 1930 : Aberystwyth (Wales) Welsh Plant Breeding Station. F. Nilsson 1935 : Weibullsholm (Scania), Sweden.
14. *Festuca arundinacea* Schr. × *Festuca pratensis* Huds.	II I	Jenkin 1924, 1928. E. Vogt 1931.
15. *Festuca arundinacea* Schr. × *Festuca rubra* L.	I	Jenkin, 1921, 1928.
16. *Festuca arundinacea* Schr. × *Festuca rubra* L., *eu-rubra* Hack.	O	E. Vogt 1931.
17. *Festuca arundinacea* Schr. × *Festuca rubra* L. var. *genuina* Hack.	I	E. Vogt 1931.

* Degrees : O = completely sterile. I = almost completely sterile. II = fertility very greatly reduced. III = fertility reduced. IV = fertility somewhat reduced. V = completely fertile.

TABLE 2—*continued.*

Hybrids.	*Degree of fertility or sterility.	Author, year and place in which the hybridization was carried out.
18. *Festuca arundinacea* Schr. × *Lolium italicum* A. Br.		J. Garton 1893: Newton-le-Willows (Lancashire), England.
	I	E. Vogt 1931.
19. *Festuca arundinacea* Schr. × *Lolium perenne* L.		J. Garton 1893.
	II	Jenkin, 1921, 1928, 1930.
	II	E. Vogt 1931.
20. *Festuca gigantea* Vill. × *Festuca arundinacea* Schr.	III	Jenkin 1930. F. H. Peto 1933.
21. *Festuca gigantea* Vill. × *Festuca pratensis* Huds.	I	E. Vogt 1931.
22. *Festuca gigantea* Vill. × *Lolium perenne* L.	O	F. Nilsson 1928, 1929: Weibullsholm.
23. *Festuca loliacea* (= *Festuca pratensis* Huds. × *Lolium perenne* L.) × *Festuca pratensis* Huds.		Jenkin 1933.
Festuca loliacea (= *Festuca pratensis* Huds. × *Lolium perenne* L.) × *Lolium perenne* L.		Jenkin 1933.
25. *Festuca ovina* L. × *Festuca rubra* L.	I	Jenkin, 1930.
26. *Festuca ovina* L. × *Lolium perenne* L.		J. Garton 1893.
27. *Festuca pratensis* Huds. × *Festuca arundinacea* Schr.	III	Jenkin 1924, 1928.
	I	E. Vogt 1931.
28. *Festuca pratensis* Huds. × *Festuca gigantea* Vill.	III	Jenkin 1930.
29. *Festuca pratensis* Huds. × *Festuca rubra* L.	I	Jenkin 1922, 1928, 1930, 1931.
30. *Festuca pratensis* Huds. × *Festuca rubra* L., *eu-rubra* Hack.	I	E. Vogt 1931.
31. *Festuca pratensis* Huds. × *Festuca rubra* L., var. *genuina* Hack.	I; II	E. Vogt 1931.
32. *Festuca pratensis* Huds. × *Lolium italicum* A. Br.		J. Garton 1893.
	I	J. Knoll 1926: Institut für Pflanzenbau u. Pflanzenzüchtung der Landwirtschaftlichen Hochschule Hohenheim, Württemberg.
	O	N. Vavilov, before 1928 (according to Knoll): Leningrad, Inst. Appl. Bot. St.-Yves 1929: Vernon-sur-Brenne, France. O. R. Holmberg 1930: Stockholm. S. Andersen 1931: Holte, Denmark.
	I; II	E. Vogt 1931: Zerrehne.

* Degrees: O = completely sterile. I = almost completely sterile. II = fertility very greatly reduced. III = fertility reduced. IV = fertility somewhat reduced. V = completely fertile.

TABLE 2—*continued.*

Hybrids.	*Degree of fertility or sterility.	Author, year and place in which the hybridization was carried out.
33. *Festuca pratensis* Huds. × *Lolium perenne* L.		J. Garton 1893.
	I	J. Knoll 1926 : Hohenheim.
	O	N. Vavilov, before 1928 : Leningrad.
	II	Jenkin 1922, 1928, 1931.
	I	E. Vogt 1931.
34. *Festuca pratensis* Huds. × (*Lolium perenne* L. × *Lolium italicum* A. Br.).		Jenkin 1922, 1928–1931 : Aberystwyth.
35. *Festuca pratensis* Huds. × *Glyceria fluitans* Schr.	O	E. Vogt 1931.
36. *Festuca rubra* L. × *Festuca arundinacea* Schr.	II	Jenkin 1921, 1928.
37. *Festuca rubra* L. × *Festuca ovina* L.	I	Jenkin 1930.
38. *Festuca rubra* L. × *Festuca pratensis* Huds.	I	Jenkin 1928, 1930, 1931. W. Hertzsch 1932 : Zweigstelle des Kaiser-Wilhelm-Institutes für Züchtungsforschung, Klein-Blumenau, East Prussia.
39. *Festuca rubra* L. × *Lolium perenne* L.	I	Jenkin 1921, 1922, 1928.
	I ; O	F. Nilsson 1929, 1930 : Weibullsholm.
40. *Glyceria fluitans* L. × *Lolium perenne* L.	O	Jenkin 1931.
41. *Lolium italicum* A. Br. × *Lolium perenne* L.		J. Garton 1893. P. Boeker 1920 : Oldenburgische Saatzuchtgesellschaft Etzhorn (Oldenburg).
	IV	J. Knoll 1926 : Hohenheim.
	I	F. Nilsson 1926 : Weibullsholm. M. Rozkov 1930 to 1931 : Moscow Plant Breeding Station, Moscow.
	III	E. Vogt 1931 : Zerrehne.
42. *Lolium italicum* A. Br. × *Lolium rigidum* Gaud.		H. C. Trumble and J. F. Phipps 1932 : Waite Agricultural Research Institute, Glen Osmond, South Australia.
43. *Lolium italicum* A. Br. × *Festuca arundinacea* Schr.		J. Garton 1893.
	O ; III	E. Vogt 1931.
44. *Lolium italicum* A. Br. × *Festuca gigantea* Vill.	O ; I	F. Nilsson 1928 : Weibullsholm.
45. *Lolium italicum* A. Br. × *Festuca pratensis* Huds.		J. Garton 1893. N. Vavilov, before 1928 (according to Knoll).
	I	J. Knoll 1926.
	I ; II	E. Vogt 1931.

* Degrees : O = completely sterile. I = almost completely sterile. II = fertility very greatly reduced. III = fertility reduced. IV = fertility somewhat reduced. V = completely fertile.

TABLE 2—*continued.*

Hybrids.	*Degree of fertility or sterility.	Author, year and place in which the hybridization was carried out.
46. *Lolium perenne* L. × *Lolium italicum* A. Br.		J. Garton 1893. H. N. Frandsen 1911 : Tystofte, Denmark, Experiment Station. J. Hessing 1913 : Plant Breeding Station of the State Agricultural College, Wageningen, Holland.
	I	J. Knoll, 1926 : Hohenheim.
	I	F. Nilsson 1926 : Weibullsholm. K. Weller 1929 : Weihenstephan, Oberbayern, Bayer. Landessaatzuchtanstalt. Jenkin 1931 : Aberystwyth.
	I ; II ; III	E. Vogt 1931 : Zerrehne. A. H. Woodforde 1933 : Hobart (Tasmania), University of Tasmania.
47. *Lolium perenne* L. × *Lolium rigidum* Gaud.		H. C. Trumble and J. F. Phipps 1932 : Waite Agricultural Research Institute, Glen Osmond, South Australia.
48. *Lolium perenne* L. × *Lolium temulentum* L.	III	Jenkin 1934–1935.
49. *Lolium perenne* L. × *Avena elatior* L.	O	Jenkin 1921.
50. *Lolium perenne* L. × *Dactylis glomerata* L.	O	Jenkin 1921.
51. *Lolium perenne* L. × *Festuca arundinacea* Schr.		J. Garton 1893.
	II	Jenkin 1921, 1928, 1929, 1931.
52. *Lolium perenne* L. × *Festuca gigantea* Vill.	O	F. Nilsson 1928, 1929.
53. *Lolium perenne* L. × *Festuca ovina* L.		J. Garton 1893.
	I	Jenkin 1930.
54. *Lolium perenne* L. × *Festuca pratensis* Huds.		J. Garton 1893. Jenkin 1922, 1928–1931 : Aberystwyth.
	I	J. Knoll 1926 : Hohenheim.
	O	N. Vavilov, before 1928 (according to Knoll) : Leningrad.
	O ; I ; IV	E. Vogt 1931 : Zerrehne.
55. *Lolium perenne* L. × *Festuca rubra* L.	II	Jenkin 1921, 1924, 1928.
	O	F. Nilsson 1929, 1930 : Weibullsholm.
56. *Lolium temulentum* L. × *Lolium perenne* L.	I ; III	Jenkin 1922, 1934–1935.
57. *Phalaris arundinacea* L. × *Phalaris canariensis* L.	I ; I	E. Vogt 1931 : Zerrehne.
58. *Phalaris arundinacea* L. × *Phalaris tuberosa* (*bulbosa*) L.		Jenkin 1921 : Aberystwyth. Jenkin and Sethi 1932 : Aberystwyth.

* Degrees : O = completely sterile. I = almost completely sterile. II = fertility very greatly reduced. III = fertility reduced. IV = fertility somewhat reduced. V = completely fertile.

TABLE 2—*continued.*

Hybrids.	*Degree of fertility or sterility.	Author, year and place in which the hybridization was carried out.
59. *Phalaris tuberosa* (*bulbosa* L.) × *Phalaris arundinacea* L.	O	Jenkin 1930.
60. *Phleum alpinum* L. × *Phleum pratense* L.		J. W. Gregor and F. W. Sansome 1926 : Corstorphine near Edinburgh, Station of the Scottish Society for Research in Plant Breeding.
61. *Phleum pratense* L. × *Phleum pratense* L. var. *nodosum* (L.) Richt. (=*P. bulbosum* Host).		A. Müntzing 1935 : Svalöf, Sweden.
62. *Poa arachnifera* Torrey × *Poa pratensis* L.	I	G. W. Oliver 1904 : Arlington Farm of the U.S. Department of Agriculture, Bureau of Plant Industry, Washington (D.C.).
63. *Poa nemoralis* L. × *Poa pratensis* L.	III	E. Vogt 1931 : Zerrehne.
64. *Poa pratensis* L. × *Poa annua* var. *reptans* Hausskn.	O	E. Vogt 1931 : Zerrehne.

* Degrees : O = completely sterile. I = almost completely sterile. II = fertility very greatly reduced. III = fertility reduced. IV = fertility somewhat reduced. V = completely fertile.

Table 3. Chromosome Numbers.

Genus. Species.	Type according to Tischler (I–IV*).	n**				Highest number of chromosomes.	Author, year.
Andropogon L.	I.	10	20		60	60	
Andropogon halepensis (L.) Brot. ..		10		40			Avdulov, 1928. Favorov, 1928. Kattermann, 1930. Kiesselbach and Petersen, 1925. Rau, 1929, Favorov, 1929. Morinaga, Fukushima, Kano, Maruyama and Yamasaki, 1929. Kuwada, 1917. Favorov, 1929. Kuwada, 1915, 1919. Kuwada, 1915, 1919. E. Marchal, 1920. Morinaga and others, 1929. Nakajima, 1930. Avdulov, 1928.
Andropogon sorghum Brotero. ..			20				
Andropogon sorghum Brot. var. *sudanensis* Piper.			20				
Andropogon sorghum var. *obovatus* Hack.			20				
Andropogon sorghum var. *vulgaris* Hack.			20				
Andropogon intermedium R. Br. ..					60		
Cymbopogon Sprengel.	I.	10	20			20	
Cymbopogon nardus Rendle. ..			20				
Coix L.	I.	10	20			20	Kuwada, 1915, 1919.
Coix lacrimae-Jobi L.			20				Kuwada, 1915, 1919.
Tripsacum L.	I.	9			72	72	Longley, 1924. Taylor, 1925
Tripsacum dactyloides L.					72		Avdulov, 1931.
Tripsacum lanceolatum Rupr. ..					±70		Longley, 1924.
Tripsacum laxum Nash.					±70		Longley, 1924.
Tripsacum pilosum Scribner. ..					±70		Longley, 1924.

* I.=*Chrysanthemum* type. II.=*Antirrhinum* type. III.=*Pinus* type. IV.=*Carex* type.

** The chromosome numbers in brackets are given by some authors as anomalies.

Table 3. Chromosome Numbers.

Genus. Species.	Type according to Tischler (I–IV*).	n**						Highest number of chromo-somes.	Author, year.
Panicum L.	I.	9	18		36		54	54	
Panicum crus-galli var. *frumentaceum* Hook.							54		Avdulov, 1928.
				28					Church, 1930.
Panicum miliaceum L.					36				Avdulov, 1931.
			20						Church, 1930.
Pennisetum Pers.	I.	9	18	27	36	45	54	54	
Pennisetum glaucum R. Br. (*orientale* Richt.).					36				Avdulov, 1928.
Pennisetum setosum (Sw.) Richt.							54		Avdulov, 1928.
Pennisetum spp.			18	27	36	45	54		Avdulov, 1928, 1931.
Setaria L.	I.	9	18		36			36	
Setaria glauca (L.) P.B.					36				Avdulov, 1928.
Setaria italica Beauv.			18						Avdulov, 1928. Morinaga and others, 1929. Nakajima, 1930.
Setaria verticillata (L.) P.B.					36				Avdulov, 1928.
Setaria viridis (L.) P.B. var. *Weinmannia* (R. et S.) A. et Gr.			18						Avdulov, 1928.
Phalaris L.	IV.	(6)7	(12)14		28			28	
Phalaris arundinacea L.					28				Avdulov, 1928.
		7							Church, 1929.
					28				Jenkin and Sethi, 1932.
Phalaris arundinacea L. var. *picta* A. Gray.					28				Avdulov, 1928.
			14						Church, 1929.
Phalaris canariensis L.			12						Avdulov, 1928.
		6							Church, 1929.
		6							Katterman, 1930.
Phalaris minor Retz.					28				Avdulov, 1928.
Phalaris paradoxa L.			14						Avdulov, 1931.
Phalaris tuberosa L.			14		28				Jenkin and Sethi, 1932.

* I.=*Chrysanthemum* type. II.=*Antirrhinum* type. III.=*Pinus* type. IV.=*Carex* type.

** The chromosome numbers in brackets are given by some authors as anomalies.

Table 3. Chromosome Numbers.

Genus. Species.	Type according to Tischler (I–IV*).	n**						Highest number of chromosomes.	Author, year.
Anthoxanthum L.	IV.	5	(8)10	20				20	
Anthoxanthum aristatum Boiss. ..			10						Avdulov, 1928
Anthoxanthum odoratum L.				20					Avdulov, 1928.
			10						Kattermann, 1930.
			8						E. Marchal, 1920.
Phleum L.	I.	7	14	21	28	42		42	
Phleum alpinum L.			14						Staehlin, 1929.
Phleum asperum Vill.					28				Avdulov, 1928.
Phleum Boehmeri Wibel.			14						Avdulov, 1928.
Phleum Michelii All.		7	14						Kattermann, 1930.
Phleum paniculatum Huds. var. *annuum* (M.B.) Grisebach.					28				Avdulov, 1928.
Phleum pratense L.						42			Avdulov, 1928.
				21					Kattermann, 1930.
Phleum pratense L. var. *typicum* Beck.						42			Staehlin, 1929.
Alopecurus L.	I.	7	14		28		70	70	
Alopecurus agrostis L.			14						Avdulov, 1928.
Alopecurus alpinus Sm. var. *elatus* Kom.							70		Avdulov, 1931.
Alopecurus fulvus L.		7							Kattermann, 1930.
Alopecurus geniculatus L.					28				Avdulov, 1928.
Alopecurus geniculatus L. var. *aristatulus* Torrey		7							Church, 1929.
			14						Kattermann, 1930.
Alopecurus myosuroides Huds. ..		7							Kattermann, 1930.
Alopecurus pratensis L.			14						Marchal, 1920.
					28				Avdulov, 1928.
			14						Church, 1929.
			14						Kattermann, 1930.
					28				G. Rancken, 1934.

* I.=*Chrysanthemum* type. II.=*Antirrhinum* type. III.=*Pinus* type. IV.=*Carex* type.
** The chromosome numbers in brackets are given by some authors as anomalies.

Table 3. Chromosome Numbers.

Genus. Species.	Type according to Tischler (I–IV*).	n**					Highest number of chromosomes.	Author, year.
Agrostis L.	I.	7	14		28	42	42	
Agrostis alba L.						42		Avdulov, 1928.
Agrostis alba var. *coarctata* Neilr. ..						42		Avdulov, 1928.
Agrostis nebulosa Boiss. et Reuter...			14					Avdulov, 1931.
Agrostis palustris Huds. (*A. alba* auct.)						42		Avdulov, 1928.
Agrostis verticillata Vill.					28			Avdulov, 1931.
Agrostis vulgaris With.					28			Avdulov, 1928.
Aspera spica venti P.B.			14					Avdulov, 1931.
Ammophila Host.	I.	7	14				14	
Ammophila breviligulata Fern. ..			14					Church, 1929.
Holcus L.	I.	7	14				14	
Holcus lanatus L.			14					Staehlin, 1929.
Holcus lanatus L. var. *argenteus* R. et S.			14					Avdulov, 1928.
Holcus mollis L.			14					Staehlin, 1929.
Deschampsia P.B.	I.	7			28		28	
Deschampsia caespitosa P.B. ..					28			Avdulov, 1928.
Deschampsia flexuosa Trin. ..					28			Staehlin, 1929.
Trisetum Pers.	I.	(6)7	14	24			24	
Trisetum flavescens Beauv. ..			14					Avdulov, 1931.
Trisetum flavescens (L.) P.B. subsp. *pratense* Pers. (Beck.)				24				Avdulov, 1931.
Trisetum sibiricum Rupr.			14					Avdulov, 1931.
Avena L.	I.	7	14		28	42	42	
Avena pubescens L.					28			Emme, 1931.

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** The chromosome numbers in brackets are given by some authors as anomalies.

Table 3. Chromosome Numbers.

Genus. Species.	Type according to Tischler (I–IV*).	n**					Highest number of chromosomes.	Author, year.
Arrhenatherum P.B.	I.	7	14	28	(40)		(40)	
Arrhenatherum elatius Mert. et Koch.				28				Aasė and Powers, 1926.
					40			J. G. Davies, 1927.
			14					Kattermann, 1930.
			14					Jenkin, 1933.
Eleusine Gaertn.	I.	9	18	36			36	
Eleusine coracana Gaertn.				36				Avdulov, 1928.
Eleusine indica (L.) Gaertn. ..			18					Rau, 1929.
Eleusine tristachya (Lam.) Kunth. ..			18					Avdulov, 1931.
Beckmannia Host.	I.	7	14				14	Avdulov, 1928.
Beckmannia eruciformis Host. var. *ramosa* Paczoski.			14					Avdulov, 1931.
Beckmannia eruciformis Host. var. *baicalensis* W. Kusnezow.			14					Avdulov, 1931.
Spartina Schreber.	I.	(7)10	(14)		(28)40	80	80	
Spartina alterniflora Loisel. var. *glabra* (Muhl.) Fern.				28				Church, 1929.
Spartina cynosuroides (L.) Willd. ..						80		Avdulov, 1928.
Spartina michauxiana Hitchcock ..			14					Church, 1929.
Spartina Schreberi J. F. Gmelin. ..					40			Avdulov, 1928.
Sesleria Scop.	I.	7	14	28	42		42	
Sesleria autumnalis (Scop.) F. Schultz				28				Avdulov, 1928.
Sesleria coerulea Scop. var. *uliginosa* Čelakovsky.			14					Kattermann, 1930.
Sesleria tenuifolia Schrader. ..					42			Avdulov, 1928

* I.=*Chrysanthemum* type. II.=*Antirrhinum* type. III.=*Pinus* type. IV.=*Carex* type.

** The chromosome numbers in brackets are given by some authors as anomalies.

Table 3. Chromosome Numbers.

Genus. Species.	Type according to Tischler (I–IV*).	n**					Highest number of chromosomes.	Author, year.
Phragmites Trin.	I.	12	(21)	36	48	96	96	
Phragmites communis Trin. ..				36				Tischler, 1918.
			21					Tischler, 1929.
					48			Avdulov, 1928.
						±96		Avdulov, 1931.
Melica L.	I.	9	18				18	
Melica altissima L.			18					Avdulov, 1928.
		9						Kattermann, 1930.
Melica ciliata L.			18					Avdulov, 1928.
Melica micrantha Boiss.			18					Avdulov, 1928.
Melica nutans L.			18					Avdulov, 1928.
		9						Kattermann, 1930.
Briza L.	IV.	(5)7	(10)14				14	
Briza elatior Sibth. et Sm.			14(–17)					Avdulov, 1928.
Briza maxima L.			14					Avdulov, 1928.
Briza media L.			14					Avdulov, 1928.
		7						Kattermann, 1930.
Briza minor L.			10					Avdulov, 1928.
Dactylis L.	I.	7	14		28		28	
Dactylis Aschersoniana Graebner. ..		7						Kattermann, 1930.
			14					Levan, 1930.
Dactylis glomerata L. ..					28			J. G. Davies, 1927.
..					28			Avdulov, 1928.
					28			Staehlin, 1929.
			14					Church, 1929.
					28			Levan, 1930.
			14(15)					Kattermann, 1930.
			14					Jenkin, 1933.
			14					G. Rancken, 1934.
					28			A. Muentzing, 1931.
Dactylis glomerata L. var. *hispanica* Koch.					28			Avdulov, 1928.

* I.=*Chrysanthemum* type. II.=*Antirrhinum* type. III.=*Pinus* type. IV.=*Carex* type.
** The chromosome numbers in brackets are given by some authors as anomalies.

Table 3. Chromosome Numbers.

Genus. Species.	Type according to Tischler (I–IV*).	n**								Highest number of chromosomes.	Author, year.
Cynosurus L.	I.	7	14							14	
Cynosurus Balansae Coss. et Durieux			14								Avdulov, 1928.
Cynosurus cristatus L.			14								Avdulov, 1928.
			14								Staehlin, 1929.
Cynosurus echinatus L.			14								Avdulov, 1928.
			14								Staehlin, 1929.
Poa L.	IV.	7	14		28	35	42	49	56	70	70	
Poa annua L.					28						Avdulov, 1928.
					28						Staehlin, 1929.
			14								Kattermann, 1930.
Poa alpina L.						32–34					Avdulov, 1928.
Poa alpina L. var. *typica* Beck. ..							42				Staehlin, 1929.
				22	—	38					Muentzing, 1933.
Poa alpina L. var. *badensis* (Hke.) Koch.							42				Staehlin, 1929.
Poa caesia Sm.							42				Staehlin, 1929.
Poa compressa L.									56		Staehlin, 1929.
							42				Avdulov, 1928.
							42				Muentzing, 1933.
Poa glauca Vahl.										70	Avdulov, 1928.
Poa nemoralis L.					28						Avdulov, 1928.
							42				Staehlin, 1929.
									56		Muentzing, 1933.
Poa palustris L.							42				Staehlin, 1929.
Poa palustris L. var. *fertilis* (Host.) Asch. et Gr.					28						Avdulov, 1928.
Poa palustris L. var. *effusa* Asch. et Gr.							42				Avdulov, 1928.
Poa pratensis L.									56		Staehlin, 1929.
								49	(64–85)		Muentzing, 1933.

* I. = *Chrysanthemum* type. II. = *Antirrhinum* type. III. = *Pinus* type. IV. = *Carex* type.
** The chromosome numbers in brackets are given by some authors as anomalies.

Table 3. Chromosome Numbers.

Genus. Species.	Type according to Tischler (I-IV*).	n**							Highest number of chromosomes.	Author, year.
L. (*con.*)										
Poa pratensis L. var. *angustifolia* (L.) Sm. f. *setacea* (Hoffm.) Rosch.					28		56			Avdulov, 1931.
Poa sterilis M.B. ssp. *versicolor* (Bess.) Richt.					28			70		Staehlin, 1929.
Poa sudetica Haenke (=*Poa Chaixii* Vill.).			14							Avdulov, 1928, 1931.
			14(+2)							Staehlin, 1929.
			14							Muentzing, 1933.
Poa trivialis L.			14							Avdulov, 1928.
			14							Staehlin, 1929.
			14							Muentzing, 1933.
Poa violacea Bell					28					Staehlin, 1929.
Glyceria R. Br.	I.	7			28		56		56	
Glyceria aquatica Wahlenb. ..							56			Avdulov, 1928.
Glyceria aquatica Wahl. var. *typica* Asch.							56			Staehlin, 1929.
Glyceria aquatica Wahl. var. *arundinacea* Ascherson.					28					Staehlin, 1929.
Glyceria fluitans R. Br.					28					Staehlin, 1929.
					28					Jenkin, 1933.
Glyceria nervata Trin.					28					Staehlin, 1929.
Glyceria plicata Fries.					28					Staehlin, 1929.
Festuca L.	I.	7	14	21	28	42	56	70	70	
Festuca alopecurus Schousb. ..			14							Avdulov, 1928.
Festuca amethystina L.					28					Staehlin, 1929.
Festuca bromoides D. Fl.			14							Staehlin, 1929.
Festuca Danthonii A. et Gr. ..					28					Avdulov, 1931.
Festuca Danthonii A. et Gr. var. *imberbis* A. et Gr.						42				Avdulov, 1928.
Festuca dertonensis A. et Gr. ..			14							Radeloff, 1930.

* I.=*Chrysanthemum* type. II.=*Antirrhinum* type. III.=*Pinus* type. IV.=*Carex* type.
** The chromosome numbers in brackets are given by some authors as anomalies.

Table 3. Chromosome Numbers.

Genus. Species.	Type according to Tischler (I–IV*).	n**						Highest number of chromosomes.	Author, year.
Festuca L. (*con.*)									
Festuca elatior L. *pratensis* Hack. ..		7							G. Evans, 1926.
var. *eu-pratensis* St. Y. ..			14						Levitsky & Kuzmina, 1927.
			14						Staehlin, 1929.
			14						Radeloff, 1930.
		7							Church, 1929.
		7							Kattermann, 1930.
		7							Katayama (not published), 1930.
		7							Jenkin, 1933.
		7							Rancken, 1934.
var. *appenina* Hack.						42			Staehlin, 1929.
arundinacea Hack.						(40)			G. Evans, 1926.
var. *eu-arundinacea* St. Y. ..				21		42			Levitsky & Kuzmina, 1927.
						42			Staehlin, 1929.
				21					Church, 1929.
						42			Radeloff, 1930.
				21					Jenkin, 1933.
var. *Uechtritziana* (Wiesb.)Hack.			over 14						de Litardière, 1923.
					28				Staehlin, 1929.
var. *glaucescens* Boiss. subvar. *corsica* St. Y.						42			Levitsky & Kuzmina, 1927.
var. *Leutourneuxiana* St. Y. subvar. *Pitardii* St. Y.								70	Levitsky & Kuzmina, 1927.
var. *cirtensis* St. Y.								70	Levitsky & Kuzmina, 1927.
Festuca geniculata Willd.			14						Avdulov, 1931.
Festuca gigantea Vill.						42			Levitsky & Kuzmina, 1927.
						42			Staehlin, 1929.
						42			Radeloff, 1930.
				21					Jenkin, 1933.
Festuca granatensis Boiss. (= *Poa scabriosa* Lag.)			14						Levitsky & Kuzmina, 1927.
Festuca heterophylla Lam.						42			Radeloff, 1930.

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Table 3. Chromosome Numbers.

Genus. Species.	Type according to Tischler (I–IV*).	n**	Highest number of chromosomes.	Author, year.
Festuca L. (*con.*)				
Festuca Mairii St. Y.		28(29-31)		Levitsky & Kuzmina, 1927.
				Staehlin, 1929.
Festuca montana M. Bieberst. (= *Festuca drymea* Mert. et Koch.)		14		Levitsky & Kuzmina, 1927.
Festuca myurus L.		14		Avdulov, 1928.
		42		Staehlin, 1929.
		42		Radeloff, 1930.
Festuca ovina L., *eu-ovina* Hack. ..		14		Levitsky & Kuzmina, 1927.
		28		Church, 1929.
		14		Turesson, 1930.
		14		Jenkin, 1933.
var. *capillata* Hack.		14		Litardière, 1923. Levitsky
		14		and Kuzmina, 1927.
		14		Staehlin, 1929.
var. *vulgaris* Hack.		14		Radeloff, 1930.
subvar. *genuina* Hack. ..		42		Staehlin, 1929.
subvar. *hispidula* Hack. .		42		Levitsky & Kuzmina, 1927.
subvar. *pilifera* St. Y. .		14 over		Levitsky & Kuzmina, 1927.
subvar. *firmula* Hack. ..		14		Litardière, 1923.
		14 over		Levitsky & Kuzmina, 1927.
subvar. *eu-vulgare*		14		Levitsky & Kuzmina, 1927.
var. *supina* Hack.				
subvar. *grandiflora* Hack. ..		14		Staehlin, 1929.
var. *duriuscula* Hack. ..		42		Levitsky & Kuzmina, 1927.
		21		Church, 1929.
		28		Staehlin, 1929.
		42		Radeloff, 1930.
subvar. *trachyphylla* Hack. ..		42		Levitsky & Kuzmina, 1927.
subvar. *genuina* Hack. ..		42		Levitsky & Kuzmina, 1927.
var. *glauca* Hack. (*pallens* ?) ..		28		Staehlin, 1929.

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** The chromosome numbers in brackets are given by some authors as anomalies.

Table 3. Chromosome Numbers.

Genus. Species.	Type according to Tischler (I–IV*).	n**					Highest number of chromosomes.	Author, year.
Festuca L. (*con.*)								
subvar. *eu-glauca* St. Y.		14						Litardière, 1923. Levitsky and Kuzmina, 1927.
		14						
subvar. *pallescens* (Host.) Hack.		14						Levitsky & Kuzmina, 1927.
Festuca ovina L., *sulcata* Hack.			28					Staehlin, 1929.
var. *Duvalii* St. Y.				42				Levitsky & Kuzmina, 1927.
var. *valesiaca* (Koch) Hack.				42				Levitsky & Kuzmina, 1927.
subvar. *eu-valesiaca* St. Y.		14						Litardière, 1923.
				42				Levitsky & Kuzmina, 1927.
		14						Staehlin, 1929.
var. *Callieri* Koch.								
subvar. *conferta* St. Y.		14						Levitsky & Kuzmina, 1927.
var. *Panciciana* Hack.			28					Staehlin, 1929.
Festuca ovina L., *laevis* Hack.								
var. *gallica* (Hack.) St. Y.		14						Levitsky & Kuzmina, 1927.
subvar. *Costei* St. Y.		14						Litardière, 1923.
var. *Halleri* (All.) Hack.		14						Staehlin, 1929.
Festuca ovina L., *frigida* Hack.								
var. *glacialis* (Miègeville) Hack.		14						Staehlin, 1929.
var. *rupricaprina* (Kern.) Hack.			28					Staehlin, 1929.
Festuca ovina L., *alpina* (Suter) Hack.								
var. *Suteri* St. Y.		14						Staehlin, 1929.
var. *Briquettii* St. Y.								
subvar. *eu-Briquettii* St. Y.		14						Litardière, 1923.
Festuca ovina L., *indigesta* Hack.								
var. *Litardieri* St. Y.							70	Levitsky & Kuzmina, 1927.
Festuca ovina L., *Beckeri* Hack.			28					Levitsky & Kuzmina, 1927.
Festuca pulchella Huter, Porta et Rigo.		14						Staehlin, 1929.
Festuca rubra L., *heterophylla* (Lam.) Hack.				42				Levitsky & Kuzmina, 1927.
				42				Staehlin, 1929.
Festuca rubra L., *violacea* (Gaud.) Hack.		14						Staehlin, 1929.

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Table 3. Chromosome Numbers.

Genus. Species.	Type according to Tischler (I–IV*).	n**	Highest number of chromosomes.	Author, year.
Festuca L. (*con.*)				
Festuca rubra L., *eu-rubra* Hack.		21		Church, 1929.
		21		Jenkin. F. H. Peto, 1933.
var. *genuina* Hack.		56		Levitsky & Kuzmina, 1927..
subvar. *vulgaris* Hack.		56		Levitsky & Kuzmina, 1927
		42		Staehlin, 1929.
subvar. *arenaria* (Fries) Hack.		42		Staehlin, 1929.
var. *multiflora* A. et Gr.				
subvar. *planifolia* (Trautv.) Hack.		42		Staehlin, 1929.
var. *fallax* Hack.		42		Staehlin, 1929.
Festuca rubra L., *nevadensis* Hack.			(68-)70	Levitsky & Kuzmina, 1927.
var. *Hackelii* Lit. et Maire.				
subvar. *brevifolia* Lit. et Maire				
Festuca silvatica (Poll.) Vill.		42		Staehlin, 1929.
		42		Radeloff, 1930.
Festuca spadicea L.		14		Levitsky & Kuzmina, 1927.
		14		Staehlin, 1929.
var. *genuina*		14		Radeloff, 1930.
subvar. *aurea* Lam.		28		Litardière, 1923.
Festuca spectabilis Jan.		42		Staehlin, 1929.
Festuca triflora Desf.		14		Levitsky & Kuzmina, 1927.
Festuca varia Haenke, *eu-varia* Hack.				
var. *genuina* Hack.		28		Litardière, 1923.
		28		Staehlin, 1929.
subvar. *typica* Hack.		14		Litardière, 1923.
		14		Levitsky & Kuzmina, 1927.
var. *scabriculmis* Hack.		28		Staehlin, 1929.
		over 14		Litardière, 1923.
subvar. *vulgaris* Hack.		14		Levitsky & Kuzmina, 1927.
var. *flavescens* (Bell.) A. et Gr.		14		Staehlin, 1929.

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Table 3. Chromosome Numbers.

Genus. Species.	Type according to Tischler (I–IV*).	n**					Highest number of chromosomes.	Author, year.
Festuca L. (*con.*)								
Festuca varia Haenke, *scoparia* Kern. et Hack.								
var. *eu-scoparia* Hack. ..								
subvar. *Kerneri* St. Y. ..			14					Litardière, 1923.
subvar. *genuina* Hack. f. *crinum ursi* Ram.			14					Staehlin, 1929.
Festuca varia Haenke, *eskia* (Ram.) St. Y.					42			Staehlin, 1929.
Bromus L.	I.	7	14	28	42	56	56	
Bromus arduennensis Dum. ..			14					Staehlin, 1929.
Bromus arvensis L.			14					Avdulov, 1928.
			14					Staehlin, 1929.
Bromus australis Sprengel				28				Staehlin, 1929.
Bromus breviaristatus Buckl. ..						56		Staehlin, 1929.
Bromus briziformis F. and M. ..			14					Avdulov, 1928.
Bromus cappadocicus Boiss et Bal.					42			Staehlin, 1929.
Bromus carinatus Hook. et Arn. ..						56		Staehlin, 1929.
Bromus ciliatus L.						56		Avdulov, 1931.
			14					Staehlin, 1929.
var. *purgans* Gr.			14					Staehlin, 1929.
Bromus Danthonii Trin.			14					Avdulov, 1928.
Bromus erectus Huds., *eu-erectus* A. et Gr.					42			Staehlin, 1929.
Bromus erectus Huds., *stenophyllus* Lam.					42			Staehlin, 1929.
Bromus inermis Leysser.						56		Avdulov, 1928.
					42			Staehlin, 1929.
Bromus intermedius Guss.			14					Avdulov, 1928.
Bromus japonicus Thunb. (=*patulus* M. et Koch)			14					Avdulov, 1928.
Bromus Kalmii A. et Gr.			14					Staehlin, 1929.
			14					Staehlin, 1929.

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Genus. Species.	Type according to Tischler (I–IV*).	n**						Highest number of chromosomes.	Author, year.
Bromus L. (*con.*)									
Bromus macrostachys Desf.				28					Avdulov, 1928.
			14						Staehlin, 1929.
Bromus madritensis L.				28					Avdulov, 1928.
					42				Staehlin, 1929.
Bromus marginatus Nees.						56			Avdulov, 1931.
Bromus maximus Desf. (=*villosus* Forsk.).					(42)	56			Avdulov, 1928.
						56			Staehlin, 1929.
var. *Gussoni* Parl.				28					Staehlin, 1929.
Bromus mollis L. (=*hordeaceus* L.)				28					Avdulov, 1928.
				28					Staehlin, 1929.
Bromus pacificus Shear.					42				Staehlin, 1929.
Bromus polyanthus Scribner					42				Staehlin, 1929.
Bromus pumpellianus Scribner.					42				Staehlin, 1929.
Bromus purpurascens Del. (=*rubens* L.).				28					Staehlin, 1929.
Bromus ramosus Huds. var. *eu-ramosus* A. et Gr.			14						Staehlin, 1929.
Bromus secalinus L.				28					Avdulov, 1928.
				28					Staehlin, 1929.
Bromus sitchensis Bong.					42				Staehlin, 1929.
Bromus squarrosus L.			14						Staehlin, 1929.
Bromus sterilis L.			14						Staehlin, 1929.
Bromus tectorum L.			14						Avdulov, 1928.
var. *typicum* A. et Gr.			14						Staehlin, 1929.
var. *longipilus* Kum. et Sendtner			14						Staehlin, 1929.
Bromus unioloides Humb. et Kunth (=*Ceratochloa Schraderi* Kunth).				28					Staehlin, 1929.
					42				Avdulov, 1931.
Bromus variegatus Bieb.					42				Staehlin, 1929.
Bromus virens Buckl. (=*carinatus Hookerianus* Shear).			14						Staehlin, 1929.
Brachypodium P.B.	I.	9	18					18	
Brachypodium silvaticum Roem. et Schult.			18						Avdulov, 1928.

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Table 3. Chromosome Numbers.

Genus.	Species.	Type according to Tischler (I–IV*).	n**						Highest number of chromosomes.	Author, year.
Nardus L.		I.	13	26					26	
	Nardus stricta L.			26						Avdulov, 1928.
Lolium L.		I.	7	14					14	
	Lolium italicum A. Br.		7							G. Evans, 1926.
	Lolium linicolum Sonder.			14						Avdulov, 1928.
	Lolium perenne L.			14						Faworski, 1927.
			7							G. Evans, 1926.
				14						Faworski, 1927.
				14						Katayama (not published), 1929.
	(abnormalities also)			14						Nakajima, 1930.
			7							Kattermann, 1930.
			7							Jenkin, 1933.
	Lolium persicum Boiss.			14						F. Nilsson, 1934.
	Lolium temulentum L.			14						Faworski, 1927.
				14						Faworski, 1927.
Agropyrum P.B.		I.	7	14	21	28	42		42	
	Agropyrum cristatum (L.) P.B.			14						F. H. Peto, 1929.
	Agropyrum Griffithsii		7							Peto, 1929.
	Agropyrum orientale (L.) R. et Sch.					28				Avdulov, 1928.
	Agropyrum repens (L.) P.B.						42			Stolze, 1925.
					21					Lange, 1929.
						28				Mowery, 1929.
						28				Avdulov, 1931.
	Agropyrum Richardsonii			14						Peto, 1929.
	Agropyrum sibiricum (Willd.) P.B.					28				Avdulov, 1928.
	Agropyrum tenerum Vasey			14						F. H. Peto, 1929.
						28				Avdulov, 1931.
Elymus L.		I.	7			28	42	56	56	
	Elymus arenarius L.							56		Staehlin, 1929.
	Elymus canadensis L.					28				Avdulov, 1928.
	Elymus dahuricus Turcz.					28				Staehlin, 1929.
	Elymus sibiricus L.						42			Avdulov, 1928.
						28				Avdulov, 1928.

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FORAGE CROP MANAGEMENT ON THE BLACK SOILS AND IN THE ASPEN GROVE BELT OF WESTERN CANADA.

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THE Aspen belt, or Park belt, lies directly to the north and east of the "True prairie" (see map). It is characterized by its very dark brown or black soil which is covered with long grass and aspen bluffs. The area has a somewhat greater rainfall than the prairie country, and the lower evaporation makes a greater amount of

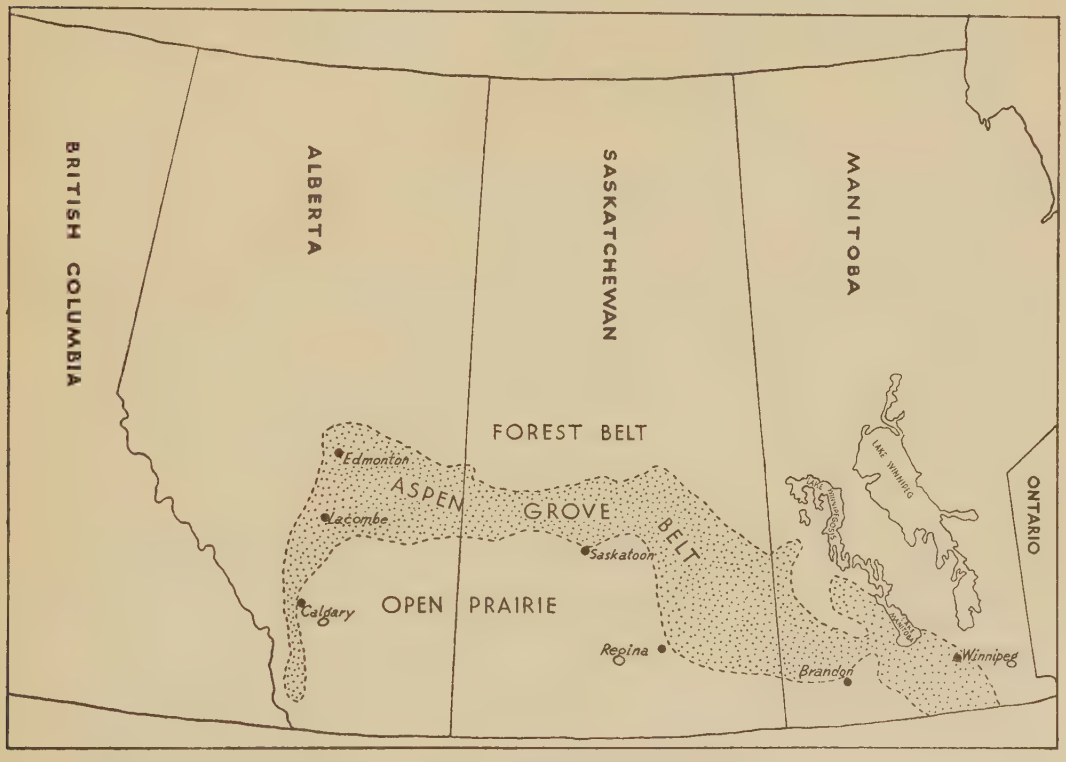

FIG. 1.—OUTLINE MAP OF THE PRAIRIE PROVINCES OF CANADA. THE ASPEN GROVE BELT IS A TRANSITION ZONE BETWEEN THE OPEN PRAIRIE TO THE SOUTH AND THE FOREST BELT ON THE NORTH.

moisture available for crop growth. In general, the annual rainfall of the Park belt ranges from 15 to 20 inches; as about two-thirds falls between April and September, there is usually ample for crop production.

While the mean July temperature is practically the same throughout the area, the period between seeding and the first killing autumn frost varies considerably. In the south-eastern end of the Park belt the number of days between the date that seeding is general and the date of the first killing autumn frost averages about 165, while in the north-western end of the belt it averages about 130 days, a difference

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of over 30 days between southern Manitoba and the Edmonton district. This fact in itself will account for most of the differences in cultural methods recommended by experimentalists working in the Park belt.

GENERAL CULTURAL PRACTICES.

Before attempting to summarize the various cultural methods for forage crops, questionnaires were sent to the Universities of Saskatchewan and Alberta, and the Dominion Experimental Stations situated in the Park belt in these provinces. The statements concerning Manitoba are based upon experimental results at Brandon and the recommendations of the Manitoba Agronomists.

Cultural practices are governed by the type of crop and its utilization. Biennials and perennials provide the main or permanent hay and pasture crops. Annuals are usually emergency or supplementary crops.

BIENNIALS AND PERENNIALS.

Brome—*Bromus inermis* ;
Western rye—*Agropyron tenerum* ;
Crested wheat—*Agropyron cristatum* ;
Sweet clover—*Melilotus alba* ;
Alfalfa—*Medicago media.*

The Nurse Crop. Because of the differences in length of growing season and the variation in soil moisture within the Aspen Grove belt, three general methods of seeding are being practised. Throughout the greater part of the farming area in Manitoba, the growing season is considerably longer than in the remainder of the belt. Here it is becoming a common practice to seed grasses, clovers, and alfalfa with a wheat nurse crop on summer-fallowed land, the nurse crop being reduced to two-thirds the usual rate of seeding. The wheat is harvested by mid-August, which gives the grass seedlings approximately a month and a half to two months to become well established before freeze-up.

In north-western Manitoba and north-eastern Saskatchewan, moisture is more abundant. The general practice in this district is to seed down with the second or third grain crop after summer-fallow. In other districts this method is successful only in seasons of above average rainfall. The nurse crop is usually oats or barley which ripen early and gives the young hay crop a chance to become established before the land freezes.

As one moves further north and west, the time between grain harvesting and freeze-up is shorter and from results obtained at Edmonton and Lacombe, this period is too short for satisfactory development of the grass. There the seeding of grasses and legumes without a nurse crop is gaining in favour.

Where the nurse crop is not advisable, the use of stubble land is more economical than summer-fallow, provided the land is clean before sowing. Fall or spring ploughing should be thoroughly cultivated up to the time of seeding to remove weed growth. Packing before seeding is advisable as it makes a firm seed bed and prevents the drill from going too deep into the soil. Shallow seeding to a depth of not more than one inch, if possible, is most satisfactory.

Time of seeding depends upon the method of planting and the condition of the soil. If seeding is done on summer-fallow with a wheat nurse crop, then the earlier the better, about May 1. In all events early seeding is preferred to late seeding as during the month of May moisture conditions are usually more favourable for germination than later. However, it may be necessary to delay seeding until mid-June in order to free the land from weeds, under which conditions it may be advisable to seed with about half a bushel of oats. These may be cut for hay and at the same time used to protect the seedling grass from the hot sun.

Rate of seeding. The recommended rates of seeding are similar throughout the whole of the Park belt. For pasture purposes several pounds more seed per acre are used than for hay. In general, however, brome, western rye, and sweet clover are sown at 15 to 20 lb. per acre and crested wheat and alfalfa at 10 to 15 lb. per acre. The reduced rate of the last two crops is due largely to the high price of seed.

Clipping. When the crop is sown without a nurse crop, clipping is usually necessary to prevent weeds from going to seed. Unless very rank, the first year's growth should not be disturbed so as to afford good winter protection. This is particularly true of alfalfa. There is always the temptation to pasture first-year growth, but such a practice usually results in a very disappointing stand in the following year. With sweet clover and alfalfa, it is advisable to have a top-growth of at least 8 to 12 inches for winter covering.

If proper care has been taken in the choice of good seed, preparation of the seed-bed and subsequent management of the crop throughout the year of seeding, one is almost always assured of a good stand of hay or pasture the following year. The first year is one of establishment and any negligence during this period will affect production in subsequent years.

The management methods following the seeding year will depend upon the place of the crop in the farm system, whether it is to be part of a rotation or set apart as a permanent hay or pasture field. In the first case, it must be considered in the light of the rotation as a whole.

Sweet clover, being a biennial, is suitable for a short rotation, and its place in the rotation will govern its treatment. In Manitoba, where a nurse crop is used, a common rotation is 1st year—fallow, 2nd year—wheat seeded down to sweet clover, 3rd year—hay and plough after first cutting, 4th year—wheat or coarse grain. In this rotation the hay stubble is ploughed up by mid-July and the land fallowed for the remainder of the season. Following this treatment, the yield of the succeeding grain crop is practically equal to that sown on summer-fallow. If two cuttings of clover are taken, or the aftermath pastured, the following grain crop is no better than that on stubble.

In districts where the nurse crop is inadvisable because of shortness of season, it is usual to take a second hay cutting of sweet clover or to pasture it. Sweet clover, therefore, is usually the last crop in the rotation or the crop immediately preceding the summer-fallow.

Throughout the whole of the Park belt there is a tendency on the part of farmers to allow the sweet clover to become too tall and rank before cutting. The tonnage may be greater but the quality will be poor and a great deal more wastage occurs in feeding. It is preferable to cut when the crop is about 25 per cent in bloom.

Alfalfa is frequently cut too late and yields from second cuttings are, therefore, greatly reduced. As with sweet clover it should be cut when 25 to 33 per cent in bloom. Alfalfa is an excellent pasture crop, but care should be taken to remove stock early enough in the autumn to permit sufficient top growth to be made for winter protection and root storage.

The grasses rarely give more than one cutting of hay per year, but the aftermath will afford good pasture. They are best cut shortly after they are fully headed, when they have made maximum growth but have not become too fibrous. The grasses differ in duration of productivity. Western rye is not very satisfactory after its second cropping year, whereas brome and crested wheat may remain for a considerably longer period. Alfalfa is usually productive for at least five years and in many cases longer.

Cutting and curing. While sweet clover is quite commonly cut with the mower, it is more general to use the binder. The method commonly used is to make small, loose sheaves which are allowed to wilt for about a day before stooking. The chief drawback to this system is that it takes any time up to three weeks, depending upon

weather conditions, for the hay to become sufficiently dry to stack properly. Some stack when the hay is quite green by spreading liberal amounts of salt (10 lb. per ton of hay) in layers at the time of stacking.

Another method which has proved quite satisfactory at Brandon is cutting with the binder, but with the knotting device disconnected. The clover then runs over the canvases and falls behind in a windrow. If weather conditions are good, the hay may be stacked after four or five days, thus saving considerable time and allowing the land to be ploughed earlier. The quality of the hay is as good, if not better, than that cured in the stook.

Grasses are cut with the mower and generally cured in the swath. However, if raked shortly after cutting and cured in the windrow, the colour and quality of the hay is usually improved. Alfalfa is cut with the mower and should be cured in the windrow. Otherwise the leaves become too brittle and considerable loss occurs during subsequent handlings.

ANNUAL CROPS.

Oats and Barley ;
Millet ;
Corn (maize) ;
Sorghum ;
Sunflower.

Annual crops are grown as cleaning crops, or to supplement hay or pasture shortage, or to add variety to the ration. Because of the great differences in the kinds of crops grown, cultural methods naturally vary.

Throughout the whole of the Park-belt *oats* is the most common annual forage crop. It is generally sown late in order to give the land a good cleaning before seeding ; but, if the land is fairly clean, it is preferable to sow before the middle of May to facilitate early cutting. Too frequently the crop is allowed to become too mature before cutting for hay, even when the material is really grain and straw. For best quality the crop is cut when the oat kernels are just coming into the milk stage, when the stems have greatest feed value.

Barley hay is grown in the same manner as oats, but possibly sown a little later, and is used considerably as a smother or cleaning crop.

Millets and *Sudan grass* are quick growing hot weather crops which are grown to some extent in southern Manitoba. Elsewhere in the Park belt they are of little importance. They are susceptible to frost, and must be sown after all danger of damage is over, i.e. about the last week in May. Neither crops compete well with weeds in the seedling stage, and the land should, therefore, be well cleaned before seeding. Once the warm weather sets in, growth is rapid and the small weeds are smothered. If the foxtail millets are grown, the hay should be cut just after heading, or the bristles on the heads become harsh and cause irritation in the throats of stock.

While *corn* may be grown over a large part of the Park belt, it is mainly confined to the south-eastern portion. It is too frequently considered as a cleaning crop, but as such it can be a complete failure. Unless the land is kept clean by repeated cultivations, infestation with weeds may be worse after corn than before. At Brandon land is harrowed well before planting and the harrowing continued as required until the plants are about six inches high. The later harrowings are usually done in the afternoon when the plants are somewhat wilted, so that less breakage occurs. After the plants are six inches high, the crop is treated as any intertilled crop, cultivating being down between the rows until too tall. There is very little difference in yield between hill planting and row planting. Hill planting has the advantage of requiring less seed and of permitting cross cultivation. If a corn planter is not available, row seeding may be done with the ordinary grain drill by

stopping up the seed cups that are not required. Rows are generally 36 to 42 inches apart and hills the same distances. If sown in hills, one bushel of seed will sow four to five acres ; in rows twice this quantity will be necessary.

Corn is more resistant to spring frost injury than is generally believed and may be sown quite early. At Brandon, it is sown between May 8 and 15. At the western end of the Park belt, May 15 to 25 is the recommended period. Late seeding usually results in a very immature crop.

Sorghum is a crop that is being grown to quite an extent in southern Manitoba. It must be sown late to avoid frost, usually about May 25. It is grown in intertilled rows and treated as corn, using about 10 lb. of seed per acre. It is particularly valuable as a soiling crop, for if cut when about three feet high, a good second cut may be made.

Sunflowers are more commonly grown in the northern part of the Park belt, where they replace corn. General cultural practices are almost identical with those for corn, except that possibly sunflowers may be sown a little earlier.

SUMMARY.

The growing season is about 30 days longer in the eastern section of the Park belt than in the western. This will account for many of the differences in mangement of forage crops in the Park belt.

It is commonly recognized that a firm, fine, moist, and clean seed bed is essential for the success of biennial and perennial hay and pasture crop.

Outside the south-eastern portion of the Park belt, seeding with a nurse crop is not recommended.

Grasses and clovers should be given careful treatment until well established. Sweet clover and alfalfa should be allowed to carry into the winter a top growth of at least ten inches.

Time and method of cutting and curing are discussed. A method of cutting sweet clover with the binder, on which the knotter has been detached, is outlined.

General cultural practices for annual forage crops are mentioned briefly. The use of the harrow before and after seeding will greatly reduce the number of cultivations necessary to keep the corn crop clean.

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REVIEWS

THE ROMNEY MARSH PROBLEM.

[Reviewer : J. H. WESTERN.]

THE financial position of the Romney Marsh grazier depends essentially on the value of sheep and wool, for the whole of his living is bound up with sheep. Of recent years market prices of both sheep and wool have fallen while the cost of farming operations has increased. Under these conditions the old system of agriculture in Romney Marsh is no longer economic and new methods of management are necessary.

At present the Marsh is grazed almost exclusively by sheep and, since the land is some of the richest in the country, the stocking has to be exceptionally heavy in order to consume the amount of grass produced during the summer months. Romney Marsh carries more sheep than any other area of equal size in Britain. This very intensive grazing leads to the staling of the land and an increase of disease among the stock.

The article under review* surveys the position in this district and suggests modifications of the present farming practice whereby the plough could be introduced and better use made of the fertility stored up in the soil. If a satisfactory system can be evolved in Romney Marsh it can probably be applied successfully in other sheep grazing districts.

The Ministry of Agriculture's 4th June Returns show that there are more sheep in Kent than in any other county with the exception of Yorkshire, Northumberland, and Devon, and that a quarter of all the sheep in Kent are in Romney Marsh in the summer months. Romney Marsh comprises all the land on the seaward side of the Royal Military Canal running from Hythe to Rye, and covers 50,000 to 55,000 acres of land, i.e. about 85 square miles.

The following figures for the whole of Romney Marsh, plus the parishes of Appledore, Ruckinge, Kenardington, and Stone (which are partly in the Marsh) which have been supplied by the Ministry of Agriculture give a good idea of the farming of the Marsh :—

Acreage.	1914	1930	1935
Rough grazing	2,871	5,195	5,289
*Permanent grass	44,059	41,473	44,354
Arable land	8,991	5,615	5,976
Total acreage	55,921	52,283	55,619
*Including returns for hay	2,961	1,138	4,960

For the last 12 years the average number of sheep per 100 acres of permanent grass was 445 during the summer months, and about one-third of this figure for the winter. The acreage of arable land in the Marsh fell steadily after the War to a low level of 4,665 acres in 1931 since when it has increased slowly to 5,976 acres in June, 1935.

* Garrad, G. H. The Romney Marsh problem. Kent Education Committee, Kent, 1936. pp. 20.

The pasture may be divided into three grades, namely, fatting land, breeding land, and rough grazing land. The first of these occurs chiefly on soils where the surface layer, to a depth of from 10 to 20 inches, is a loam, or silty loam, with a slightly heavier subsoil. The high fertility of these pastures is largely due to the fact that their soil texture permits perfect natural drainage. Breeding pastures are found on heavier soils where the drainage is not so satisfactory and the land is rather wet, and also upon lighter soils which tend to be too dry. The rough grazing land occurs on very shallow soils which are either very wet or excessively dry. The better pastures have always received attention at the expense of the poorer ones and such preferential treatment has led to an improvement of some fields and a deterioration of others.

On the best fatting pastures more than 90 per cent of the total herbage may consist of the four species *Lolium perenne*, *Cynosurus cristatus*, *Poa trivialis* and *Trifolium repens*. In contrast to this, the poorest breeding pastures may contain less than 10 per cent of these four plants and there may be as many as 30 or 40 other different species present. The percentage of wild white clover is never very high, even on the best fatting pastures.

In order to consume the summer flush of grass, the grazier is often forced to buy in store sheep in May and June. Since such sheep at this time of year are in great demand, they command high prices which are not always recovered with profit when the animals are sold in the autumn. If the summer flush of grass could be disposed of in other ways a more satisfactory financial return might be obtained. It is suggested that some of the best areas might be devoted to the raising of wild white clover and indigenous perennial ryegrass, the seed of which is in great demand. A heavy dressing of basic slag in the autumn would do much to stimulate the growth of the clover.

It is the customary practice to relieve the pastures of some of the sheep by sending the lambs away at the end of August or the beginning of September, to be wintered on the uplands of Kent, Surrey, and Sussex, or elsewhere, until April. This procedure possesses certain disadvantages since the sheep are largely away from the control of their owner and many of them die during the winter. Frequently those that return to the Marsh in the following summer are in such poor condition that it takes some time for them to pick up sufficiently to be put upon the best land. The sheep which are wintered on the Marsh usually gain more quickly in the spring than those which have been sent away. It would, thus, be a decided advantage if more stock could be wintered on the Marsh. In this connexion it is suggested that one year leys of Italian ryegrass (*Lolium italicum*) might be useful, as this plant is a good producer of winter keep. Subterranean clover, *Trifolium subterraneum*, is also found on the Marsh. This plant is a self-seeding annual with a high winter productivity which might be valuable for winter grazing.

Trials have been conducted at the Wye College Farms with a system of alternate cropping, in which three to four year leys, sown with a simple seeds mixture of 12 lb. *Lolium perenne*, 2 lb. *Poa trivialis*, and 4 lb. *Trifolium repens*, follow four years of field crops. It is claimed that the sheep do far better on this new grass than on the old permanent pastures. In addition to this it is earlier and it carries more sheep to the acre. Such a system of alternate cropping, if it could be adapted for use on the Marsh, would provide a means of resting sheep-sick land since the temporary grass could be grazed and some of the permanent pasture laid up for hay. Some Marsh farmers have laid down new pastures with conspicuous success and have found that sheep will fatten more quickly on them than on their very best old pasture. One mixture that has proved very successful on many occasions is 40 lb. indigenous perennial ryegrass, 10 lb. crested dogstail (*Cynosurus cristatus*), and 6 lb. wild white clover per acre. A heavy seeding such as this produces a sward in the first year and lasts indefinitely. It is important when sowing down a pasture to select indigenous ryegrass seed, i.e. seed which has been harvested from an old high grade pasture or

which has been bred from this stock. Such seed produces a leafy persistent strain of plant, instead of the stemmy, short-lived type obtained by sowing commercial seed. For arable cultivation, to be followed by short term leys, the breeding pastures would be most suitable. Peas, beans, mangel seed, swede turnip seed, and sugar beet seed are suggested as crops likely to yield a satisfactory financial return.

Much of the worn-out arable land on the Marsh could be laid down to grass with advantage and its place taken by selected areas of second grade pasture. The problem of labour and the provision of the farm buildings necessary for a more mixed type of farming are considered.

The new process of artificially drying short leafy immature grass, if it proves economically sound, would solve many of the Romney Marsh difficulties. Disposing of the summer surplus of keep in this way would remove the necessity of buying in sheep at high prices and, at the same time, would provide valuable fodder for the winter months, so enabling the farmer to winter more of his stock on the Marsh. Since the rainfall in Romney Marsh is not high, and in some summers there is no surplus grass for drying purposes, it would be desirable to lengthen the season of grass drying by growing Italian ryegrass for cutting early in the spring and late in the autumn, and to grow lucerne to provide material for drying in a dry summer when the permanent pastures were not producing.

THE ECONOMIC POSSIBILITIES OF SPARTINA TOWNSENDII.

[Reviewer: J. H. WESTERN.]

IN the two papers under review, the author traces the history of the species *Spartina Townsendii* and describes the uses to which it has been put in Europe, and also its attempted cultivation in a number of more distant countries.

S. Townsendii was first discovered growing along the edge of Southampton Water in 1870, since when it has spread, by natural agencies, to many of the muddy estuaries along the south coast of England and the north-west coast of France. The species is believed to have arisen through hybridization between *S. stricta* and *alterniflora*, both of which occur in the locality in which *S. Townsendii* was first discovered. Cytological investigations have shown that the chromosome numbers for the three species are as follows: *S. stricta* 56, *S. alterniflora* 70, and *S. Townsendii* 126. It is also presumed that *S. Townsendii* must have originated by chromosome doubling following on interspecific hybridization. Such an origin would account for the fact that the hybrid breeds true from seed.

S. Townsendii is a robust plant with erect stems two or three feet high and extensive, underground creeping stems. From both stems two kinds of roots arise; short, fine, much-branched nutritional roots forming a dense plexus near the surface, and stout anchoring roots which descend vertically into the mud. Flowering begins in August and continues until January and sometimes later, but the bulk of the seed ripens in November, the yield varying much with the season. The period of vitality of Essex seed is very short, extending to about 14 weeks. The rate of germination is good (up to 90 per cent) in freshly gathered seed, but thereafter the rate declines rapidly.

The grass colonizes mud on clay flats from the high-water mark of spring tides down to a level about six feet below that line. It is also able to establish itself on higher level areas, known as "saltings," which normally are colonized by such plants as *Glyceria*, *Aster*, *Salicornia*, and *Obione*.

Young plants in suitable situations establish themselves rapidly and single individuals may produce a clump of vegetation up to three feet across in three years. These clumps gradually merge with one another until all the ground is covered and a "meadow" is formed. The plants consolidate the ground by their root systems and their erect shoots retard the flow of tidal currents, so causing the deposition of the material held in suspension, which raises the level of the ground. Because of these characteristics the grass has been used in England and Holland to reclaim muddy areas along the sea coast and, in Essex, it has also proved of value as a means of coast protection.

In plantations of *S. Townsendii* established in Holland in 1924–25, the level of the ground has been raised, on the average, 10 inches a year. Similar results have been obtained in other Dutch reclamation areas.

The grass is eaten readily by stock, either green or as hay, and it is possible that it may have an agricultural value overseas in regions not necessarily in close proximity to the sea.

A number of attempts have been made to grow *S. Townsendii* in warm countries and the author's second paper describes some of the results obtained. Since 1927 a considerable quantity of rooted offsets and seeds have been dispatched from England to various places, but information is not to hand in all cases as to their subsequent fate. Young plants apparently failed to maintain their position when planted in

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Bryce, J. The economic possibilities of rice grass (*Spartina Townsendii*). *Agric. Progr.* 13. 72-6. 1936.

———— *Spartina Townsendii* and *S. brasiliensis* in warm countries. *Kew. Bull.* 1936. 21–34

a small swamp in Tobago and in the Corvai Swamp in Trinidad. In 1930, 24 plants were set out in three plots in different situations in British Guiana. They failed to survive in a sandy situation covered by the higher tides, and in the other two plots, which were on mud at different tide levels, only a few plants survived, but showed no tendency to spread.

A larger consignment of offsets (150) was shipped to Venezuela in July, 1932, and three plots were planted. On one plot, situated on a salt lake shore, the grass grew well for some time and produced flowers, but the plants never became robust and gradually died out. It was concluded that the soil conditions were probably not suited to this grass.

A number of offsets from Poole were planted in a swamp in Honolulu in February, 1933. The plants established themselves and by November, 1934, each had spread to an area of about three feet in diameter and promised to spread to at least eight feet in another year. This rate of growth, which easily exceeds that obtained in Britain, may be due to the warmth of the sun and water in Honolulu.

Attempts to use *S. Townsendii* in the reclamation of salt lands in the Kassala Province of the Sudan resulted in failure. Two hundred plants, in a very saline soil and watered with salt water, succeeded in establishing themselves and growth was maintained up to the middle of April, when they wilted as the heat increased. Extra watering and a certain measure of protection failed to keep the plants alive and none had survived by the middle of June. It is believed that the limits of endurance of this species may be reached at a temperature of 104°F., since the plants died rapidly after April when this temperature was exceeded.

Seeds and plants have been sent to various parts of India, but the former failed to germinate. Information has not been received as to the fate of all of the offsets, but those planted on salt lands in the Punjab and others set along the banks of the Borelli river in Assam failed to survive.

Between 1927 and 1929 repeated efforts were made to establish *Spartina* by seed and offsets along muddy foreshores in Singapore. In spite of numerous attempts, no germination of seeds was obtained. A few offsets were planted in carefully selected sites but, although they appeared to be promising at first, they ultimately died. It is thought that climatic conditions, particularly heat, were the cause of failure.

Spartina has been grown successfully in the Riverina district of New South Wales and Victoria. The land planted was situated in a dry area, but was irrigated with artesian water containing salts, mostly sodium chloride, magnesium sulphate, and magnesium chloride. Stock drink this artesian water, but ordinary vegetation is destroyed when flooded with it. Plants of *S. Townsendii* were set in drains and under the surface of water in water-holes. The grass grew well, particularly that planted in the holes, and flowers were developed when the stems were 15 inches high. No seeds were produced. The grass continued to spread but did not make a very high growth except where the plants were permanently under water. Two years later the grass was still doing well and the tendency to multiply seemed to have increased, but the height of the shoots was less and fewer flowers were produced. The individual plants developed into clumps with a very dense growth of fine shoots in the centre around the original set and the grass quickly grew to its original height after it had been grazed down by stock. It seems probable that *Spartina* may prove of considerable economic importance in Australia on account of its ability to form a suitable fodder on inland saline soils. *S. Townsendii* has also established itself in Australia under tidal conditions, presumably similar to those obtaining in Britain.

In many parts of the world the need of a plant capable of withstanding saline conditions, either maritime or inland, has been felt. Such a plant would be invaluable in land reclamation and also in the inland saline areas, the conditions of which might

be ameliorated by continued cultivation. The *S. Townsendii* dispatched from this country has usually been intended for such purposes, but most of the attempts to grow it near the tropics have been unsuccessful. The nearest point to the equator at which this grass has been established with success is Honolulu, between latitude 20° to 21° N. It failed, however, at Kassala in the Sudan (15° to 16° N.) for reasons which are not definitely known but which appear to be unconnected with salinity since the plants did well in the early stages of growth. It is possible that a comparison of climatic conditions, including atmospheric humidity, would be of assistance in determining the failure at Kassala and other tropical regions. Factors, other than climate, may also operate. In Essex, regions are known which are apparently suitable for colonization, but in which *Spartina* is not successful. In some instance the plants have been unable to withstand the onslaughts of the common periwinkle (*Littorina littorea*) while in others failure is thought to be due to the mobility of the surface mud.

According to the author's experiments and observations it is possible to establish *S. Townsendii* in tidal regions in Great Britain where the foreshore is of a muddy nature from high-water mark of spring tides down to a level about ten feet below that line, provided the population of marine and land herbivorous animals having access to the plant, at least for the early years of establishment, is not so numerous as to cause repeated defoliation, and that the surface mud is sufficiently stable to permit the growth of such plants as *Zostera*, *Vaucheria*, and *Rivularia*. In addition, the experience of others has shown that it can also be grown in non-tidal regions of temperate and warm temperate zones, provided the soil has a salinity between about 1 and 6 per cent, and is not allowed to become parched.

Very little success has been secured in attempts to establish plantations of *Spartina* from seeds exported from this country. Even at home the young seedlings are not very robust in their first year of growth and do not compare favourably with individuals derived from offshoots of mature plants. The author believes a seed-bed to be essential and suggests that the young plants should not be transplanted until at least the end of the second year's growth.

Seeds harvested in Essex have a period of vitality of about 15 weeks during which the germination rate declines rapidly. It appears that the long journey to, or through the tropics has a depressing effect upon the germination rate of *S. Townsendii*. In the case of two samples despatched to New Zealand there was a reduction in germination of from 20 to 30 per cent, apart from the loss due to the time factor. In 1933 an effort was made to prolong the period of vitality and the best results were obtained by storage at a temperature of 4°C. By this means the period was prolonged to 42 weeks. It may be that seeds could be shipped through the tropics in cool storage but, until this has been proved, offsets are likely to give a more satisfactory test of the possibility of quickly establishing *Spartina Townsendii* in new areas.

A SURVEY OF THE AGRICULTURAL AND WASTE LANDS OF WALES.

[Reviewer: DR. T. J. JENKIN.)

THE book with the above title* consists of four sections: I. General Introduction. II. The Grasslands of Wales. III. Soil Survey in Wales. IV. Soil Survey of Sandy Coastal Areas.

The first section by the editor, Professor R. G. Stapledon, not only serves as a general introduction, but also as a general review of the remaining sections. He explains why a vegetational survey of the grasslands and grazing of Wales was undertaken, and draws attention to the use that can be made of the results of the survey. Ideally, soil and vegetation surveys should be carried out simultaneously, but as "vegetation is an index of soil fertility" and a vegetational survey can be made with relative rapidity while a soil survey is necessarily laborious, the former can be of great value even in the absence of the latter. In particular, the results of such a survey, carefully examined in the light of modern knowledge and recent experience, can assist in locating those areas that are most amenable to improvement, and in indicating the type of improvement that can be expected and the methods to be adopted for its achievement. Grassland improvement leads to accumulated fertility for arable land purposes, while ploughing with the extended use of the four to eight years' ley gives increased grassland productivity, and the one and a half million acres of *Agrostis* pasture described by Mr. William Davies in the second section of the book might be largely converted into the better *Agrostis*-ryegrass type or even into first-class ryegrass pasture. Mr. Davies himself emphasizes the possibility of grading up the various types of grassland and grazings at various points in his memoir on the grasslands of Wales. In this, the second and most extensive section of the book (pp. 13–107), methods of procedure in making the vegetational survey are described, and various considerations are discussed before proceeding to a description of the survey itself. The whole of Wales (including Monmouthshire) has been covered and a map of the scale of 0·25 inch to the mile, mounted on linen, shows the distribution of the main pasture types. This map is really only an outline, and detailed maps illustrating variations within the areas act as a key to the proper interpretation of the main outline map. The general types are themselves described in detail and tables illustrate the botanical composition of these types and the variation in certain details within the types. The approximate acreage of all types is estimated, and their distribution in each country is discussed. The actual position of large areas of certain types and the possibility of improving them is further discussed in relation to accessibility and other considerations. Not only are the areas at low elevations brought under review, but also the roughest and what appear to be the most hopeless types, so that a clear picture of the general position as it exists to-day is produced, together with a second picture in which are depicted the possibilities of the future. The whole memoir is an illustration of what a vegetational survey can do towards a better and deeper realization of the need for and possibilities of land improvement and land reclamation.

In the third section, Professor G. W. Robinson briefly describes the methods of classification used in a soil survey. He also enumerates some of the conclusions that may be drawn from the soil survey work already carried out in Wales. Land deterioration through impeded drainage, and, particularly in permanent grassland, through the depletion of lime and phosphates, is emphasized.

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* Stapledon, R. G., Davies, W., Robinson, G. W., and Roberts, E. A survey of the agricultural and waste lands of Wales. Edited for the Cahn Hill Improvement Scheme by R. G. Stapledon. 23 × 15. pp. xv + 143. Nine maps and charts. London: Faber and Faber. 1936. 15 shillings.

In the final section, Professor Robinson and Mr. Evan Roberts describe a soil survey of sandy coastal areas. Thirteen such areas, ranging from about 500 to about 6,000 acres with an aggregate of about 26,500 acres are enumerated for North Wales. Four of these areas have been surveyed and mapped. They are described with coloured map illustrations and particular conclusions are drawn for each area. All four areas together are further discussed in relation to their agricultural and horticultural possibilities, bearing in mind the expenditure that would be involved in effecting improvements. Especial emphasis is laid upon control and manurial requirements as indicated by the analysis of representative soil samples.

FORAGE CROP RESEARCH IN PRUSSIA.

[Reviewer : G. M. ROSEVEARE.]

The Reports discussed were published in *Landw. Jb.* Vol. 82. No. 4. 1936, except in two cases, as indicated.

LANDSBERG (Warthe). Preussische landwirtschaftliche Versuchs- und Forschungsanstalten. Jahresbericht. Berichtsjahr 1. April, 1934 bis 31. März, 1935. [**Prussian Agricultural and Research Stations, Landsberg (Warthe). Annual Report for the year 1st April, 1934, to 31st March, 1935.**]

FIVE separate Institutes comprise this organization. The following information is taken from their reports.

Institut für Grünlandwirtschaft. [**Grassland Institute.**]
Report by the Director, Professor A. Koenekamp, and Unglaub, Lindemann, and Siegert.

Experiments Nos. 39, 40, and 42. Five German and two Danish varieties of *Lolium italicum* were tested in pure cultures and in the " Landsberg mixture " (*Lolium, Vicia villosa,* and *Trifolium incarnatum*) for their suitablity for growing in Central East Germany. This is found to depend entirely upon winterhardiness. Three German and one Danish variety stood the test, although one very winterhardy German strain proved unsatisfactory in a mixture on account of its slow early development. A trial of the same varieties in different soil types in cement boxes again showed that utility is correlated to winterhardiness in the different strains. Confirmation was obtained of the finding that all extreme mineral soils exclude the cultivation of *Lolium italicum.*

Experiments Nos. 37, 38, 45, 46, and 49 were concerned with root growth in grass and legume species, and date from 1930. [For results see Koenekamp, *Herb. Abstr.* 5. 88 and 256. 1935.]

Experiment No. 92. A variety trial of soybeans for ensilage purposes. Seven of Prof. Riede's Bonn strains, five Austrian varieties and six from Heimburg, Brunswick, were compared. The Bonn varieties gave a uniform average yield of 244·4 dz. green weight per hectare and 7·9 dz. crude protein per hectare. Yield in the other varieties varied from 99 to 243 dz. green weight per hectare and from 5·4 to 8·5 dz. crude protein per hectare. The trial, which began in 1931, is being continued.

Experiment No. 134. Different varieties of *Vicia faba* were tested from 1933 onwards for their utility as silage crops. Of the German varieties the Zeiner bred strain gave the highest average yield of green weight and crude protein, namely 214 and 6·26 dz. per hectare respectively, but the French variety Windsor (large white) proved superior with 218·5 dz. green weight per hectare and 6·34 dz. crude protein per hectare. The trial continues.

Experiments Nos. 129 and 130. Lucerne trials. Eight Argentine, two Uruguayan, and five European lucernes were compared for their value for (*a*) grazing purposes, (*b*) mowing. The plots were sown down in 1932. In September, 1934, only 59 per cent remained of the South American stands, which were insufficiently winterhardy ; but there remained 95 per cent of the Franconian lucerne and 94 per cent of the Hungarian. The South American varieties were found to bear grazing better than the German lucernes ; of the other varieties the French and Hungarian tolerated grazing best. Thuringian lucerne proved the most palatable, and was followed closely by the Eifel, Franconian, Hugarian and Randowbruch varieties, the South American varieties being the least palatable. Grazing was done by cattle (two head) at intervals, yield resulting as follows : 1933, 880 pasture days per hectare = 4·5 head cattle per hectare for 180 days ; 1934, 620 pasture days per hectare = 3·5 head cattle per hectare for 180 days. The lower yield of the year under review is attributed

to the continuous drought, which did not allow the lucerne to recover after grazing. In the hay tests the average yield obtained in 1933 (three cuts) was, in the South American varieties, 99·8 dz. air-dry hay per hectare with 16·53 dz. crude protein per hectare, and in the European varieties 133·3 dz. green weight per hectare with 21·8 dz. crude protein per hectare.

Studies on the following subjects were continued: the influence of the water table on *Poa pratensis* and *Medicago*, the effect of increasing doses of potassium upon *Phalaris arundinacea*, the rooting of herbage and forage plants. Variety trials of grasses, soybeans, marrow stem kale, horse beans and lucerne, and manurial deficiency trials were also continued. Some former experiments were resumed, namely, one concerning the water requirements of *Poa pratensis*, and trials of sunflowers, soybeans, and protein-supplying forage plants.

Grassland improvement on the Oder. The experiments begun in 1933 were continued: (*a*) In manurial trials hay yield was increased by 35·9 dz. per hectare through full manuring with mineral fertilizers, and by 38·2 dz. per hectare when compost was added, the figures for crude protein increase being 0·53 and 6·90 dz. per hectare respectively. Full manuring improved the sward. (*b*) Trials of species and varieties. *Festuca pratensis*, in pure and mixed cultures, continued to hold the first place in suitability for the Oder lowlands, followed in order of value by *Poa palustris*, the Mahndorf strain of *Phleum* for flooded land, *Agrostis alba*, *Alopecurus pratensis*, *Beckmannia*, and *Glyceria aquatica*. The hay yields of alsike and Morsö white clover were surprisingly high. (*c*) Inter-crop cultivation. The following crops proved of value for preceding other crops; sunflowers (particularly valuable); a mixture of oats and *Vicia faba*, which was better than fodder beet, marrow stem kale, and maize. The last three are considered equal to one another in value. A permanent meadow mixture, sown down after sunflowers, yielded 125 dz. per hay hectare with a crude protein yield of 13·92 dz. per hectare. (*d*) Pasture trials. Three paddocks were grazed rotationally, two being renovated in spring, and increased productivity of 300 to 350 kg. starch equivalents is recorded in the case of the latter. Cost of production was from 6·6 to 7·8 Pf. per kg. starch equivalent (the average cost, according to Falke, is 10 Pf.). (*e*) Regulation of the water table. By means of a pump it was found that the water table could be kept at a level of from 20 to 65 cm. below the surface, according to requirements. At the same time it is possible in times of drought to admit water through sluices from a neighbouring lake. A large number of readings of the water table are being made, together with studies of the soil and ditch water for oxygen content. Trials of grassland and forage crop sowings on land formerly occupied by sedge and weeds have given good results. Hay yields of as much as 74 dz. per hectare were obtained from clover-grass mixtures, and up to 100 dz. per hectare from the pure cultures. Good to very good crops were also obtained from lupins, sunflowers, kale, roots, etc. (*f*) Meadowland renovation by extra seeding and full manuring. Increased yield of as much as 53 dz. per hectare was obtained, and the species sown in renovation, especially *Festuca pratensis* and alsike, have maintained their position well up to the present. It cannot yet be determined which of the two mixtures employed is superior in this respect. (*g*) Nine model areas have been sown down in various places and have developed well; the yield of air-dry hay varied from 60 to 80 dz. per hectare, and in one case, on heavy soil, amounted to approximately 116 dz. per hectare.

Institut für Pflanzenkrankheiten. [**Phytopathological Institute.**]

Report by the Director, Prof. Appel, and others.

Attached to the Institute is a Seed Control Station, the work of which, in consequence of the Reichsnährstand's prohibition of the growing of any seed that has not been examined, has been greatly augmented during the period under review. The Institute has also a Meteorological Station, in the charge of Dr. Saar.

Institut für Pflanzenzüchtung. [**Plant Breeding Institute.**]

Report by Prof. W. Heuser, W. Zeiner, H. Heyn, U. Lehmann, and H. Westphal.

The report covers 1934, a year characterized by drought.

Peas and beans. Trials of varieties and of peas and beans in mixtures with cereals were continued. *Vicia faba* proved extraordinarily susceptible to drought; it was hardly possible to obtain as much as 4 dz. per hectare from any of the varieties, nor did *Vicia Narbonnensis*, which was tested in comparison, give higher yields. Varieties of *Pisum* varied in susceptibility to drought, only one or two early, short forms with little straw giving yields of as much as 15 dz. per hectare, the later and more bulky forms failing.

Lupinus albus. From an Egyptian, early form, characterized by good protein and fat content, a plant low in bitter principle has been selected. In varieties from other sources forms particularly rich in fat and protein have been found, and these will be used for crossing. Results of a study of protein, fat, and alkaloid content in the seeds of *L. albus* in comparison with other lupin species and under the influence of external conditions, and of grain yield in *L. albus* and its protein and fat yield per unit area, have already been published. [See Heuser, Boekholt, and Ulich, *Herb. Abstr.* 5. 156. 1935, and Heuser, *Herb. Abstr.* 5. 332–3. 1935.] The high nutrient content of *Lupinus albus* grain has been established. The study of ecological and cultural problems in connexion with the other lupin species also was pursued, and some results have been published. [See Heuser, "Trials of time of sowing lupins," *Herb. Abstr.* 5. 156. 1935.]

Medicago. Breeding for combined fodder and seed productivity was continued. To facilitate the testing of seed productivity in bred strains, a three-year experiment on planting distance was conducted. [See Lehmann, *Herb. Abstr.* 5. 148. 1935.]

Trifolium repens and *T. hybridum*. Work was continued.

Trifolium incarnatum. The aim of breeding is increased winterhardiness, and the relatively severe winter of the period under review was of assistance in the detection of strains which survived the winter with practically no plants lost.

Grasses. Work on *Poa pratensis*, *Phleum pratense*, and *Bromus inermis* was continued. In the last-named species strains characterized by much vigour and bulk have been produced.

Institut für Bodenkunde und Pflanzenernährung. [**Institute of Soil Science and Plant Nutrition.**] Report by the Director, Prof. G. Ruschmann, and G. Pontow, E. Berger, and H. Rheinwald.

The report covers the year 1934. Manurial experiments included deficiency trials begun in 1921. In 1933 plots were sown down with lucerne. Good after-effects from farmyard manure are reported. There was no evidence of potash deficiency in the plots which received full manuring minus K_2O when farmyard manure (300 dz. per hectare) had been applied in 1931, but the evidence was very clear on the plots which had not received the previous dressing of farmyard manure.

The work of the Chemistry Department included studies of humus formation and chemical composition, and that of the Bacteriological Department the testing, on behalf of the Reichsnährstand, of certain chemical agents for the production of silage. The Soil Investigation Department studied, among other subjects, the question of green manuring.

TSCHECHNITZ, Institut für Grünlandwirtschaft der Preussischen Versuchs- und Forschungsanstalt für Tierzucht. [**Grassland Institute of the Prussian Livestock Experimental and Research Station.**]

Report by Professor Tiemann, and Windmeier.

The period covered is 1st April, 1934, to 31st March, 1935. The campaign for the popularization of ensilage has been continued ; the figures for silo construction of the standardized Tschechnitz type, expressed in cubic metres, have risen from 1,700 in 1932 to 14,000 in 1934, and the figure for 1935 is estimated at 40 to 50 thousand cubic metres. Ensilage experiments at Tschechnitz have been summarized by Rehm. [See *Herb. Abstr.* 6. 140. 1936.]

In addition to the work on ensilage, the following experiments have been conducted : (1) The use of nitrogenous fertilizers on pasture, with special reference to (*a*) the time of application, and (*b*) quantity employed. As regards (*a*), the best results were obtained from medium early application, after the first and second grazings had taken place. (*b*) Increasing the quantity of nitrogenous fertilizer from 79·5 to 106 kg. per hectare resulted in a relatively insignificant increase of productivity. (2) Farmyard manure in conjunction with watering and its effect on pastures. Of three paddocks one received in the summer 140 dz. farmyard manure per hectare and also 125 to 150 mm. artificial rain, the second received farmyard manure only, at the same rate, and the third received neither manure nor watering. Milk production on the first plot was 1,651 litres more than on the unwatered plot, while it was 300 litres more on the control plot than the second, which received farmyard manure but no watering. Reduced palatability is probably responsible for the reduced productivity of the last-named plot. The application of farmyard manure to pastures in summer is successful only if there is enough natural rain or if artificial watering can be carried out. (3) The following methods of renovating hay land were compared : (i) manuring only, (ii) harrowing or scratching and sowing with various mixtures, (iii) folding, (iv) grazing with cattle or sheep, (v) ploughing up, with or without an intermediate crop, and re-sowing ; the first process proving the least, and the last process the most successful. (4) Various crops were tested for their suitability for following a winter catch crop mixture, winter barley (on good soil) and silage lupins (on light soil) respectively. After the winter mixtures the highest starch equivalent yield was obtained from maize, the highest protein yield from Sudan grass and marrow stem kale. For following winter barley a mixture of Sudan grass, vetch, and *Pisum arvense* was most satisfactory, the Sudan grass furnishing a support for the legumes. Small-grained, early maize also furnishes a good support. On account of unusually good autumn weather marrow stem kale gave the highest protein yield. Grown after silage lupins, the absolute highest yield of dry matter (50·15 dz. per hectare) was obtained from baballa grass, an African millet ; Sudan grass, sunflowers, and bitter yellow lupins followed. In the production of digestible crude protein the bitter lupins, baballa grass, and the Sudan grass mixture took the first places, being of approximately similar value.

Variety trials of silage maize (22 varieties), fodder beet, turnips, marrow stem kale, beans, *Dactylis glomerata* and *Lolium perenne* were conducted and the following experiments were continued or begun : clover-grass and lucerne-grass sowings designed to ascertain the best mixtures under different cultural methods and for varying duration ; long duration crop rotation experiment, *Trifolium pratense* being used twice ; trials of bred strains of grasses and grasses from various sources in pure sowings and in mixtures ; investigation of the effect upon milk production and fat content of the milk of grazing dairy cows upon different grasses grown in pure cultures. Selection and breeding work in *Trifolium incarnatum*, lucerne, *Agrostis*, and *Lolium perenne* is being continued.

Institut für Futterungstechnik. [**Animal Nutrition Institute.**]

Report by Professor K. Richter and H. Brueggeman.

The above Institute, also an integral part of the Prussian Livestock Experimental and Research Institute, Tschechnitz, included in its research a study, carried out in co-operation with the Prussian Moorland Experimental Station, Bremen, of the best time for cutting moorland hay, with special reference to digestibility and nutrient content. It was found that optimal results are obtained from cutting about the middle of June. With the exception of the timothy, all the grasses, including *Holcus lanatus*, were in flower. The white clover was approximately 33 cm. long and was just about to flower. In previous studies the last third of June had been found to be the best time for harvesting. The slight discrepance between the two findings is attributed to variation in the weather conditions. [See Bruene, *Herb. Abstr.* 3. 99. 1933, and Bruene, Richter, and Brueggemann, *Herb. Abstr.* 5, 111. 1935.]

BREMEN, Preussische Moor-Versuchsstation. [**Prussian Moorland Experiment Station.**] Report by Prof. F. Bruene.

The work of the year 1934 is reported in *Landw. Jb.* 82. 585–620. 1936. There was an increase in the number of analyses of swards, of hay samples and turves made by the Botanical Laboratory.

In describing the weather conditions for the year, attention is drawn to the detrimental effect of the drought upon grassland and especially upon hay yield, which was often little more than 55 per cent of the average 80 dz. per hectare obtained in 1932, a year characterized by a moderate degree of moisture.

Manurial trials included the following : (1) In a liming trial in progress on newly cultivated high moor since 1930, yellow lupins and *Ornithopus sativus* were sown down in 1933 as green manuring. The beneficial effect of liming upon these two crops was reflected in all plots from 70 dz. $CaCO_3$ per hectare upwards ; the plot which received only 35 dz. $CaCO_3$ contained much *Molinia coerulea*, and the control plot consisted almost entirely of this grass. (2) A comparison of alkaline (basic slag) and acid fertilizers (superphosphate) in their effect upon hay leys, begun in 1930, was continued. Lime, in doses varying from 17·02 to 78·88 dz. per hectare, was applied. The amount of phosphoric acid applied in 1934 was 75 kg. per hectare. The yield from the plots receiving the alkaline fertilizer was superior throughout, with the exception of the plot receiving the next to the highest dose of lime, namely, 64·88 dz. per hectare. (3) Green manuring in its effect upon sandy heathland soil. *Lupinus albus* and *L. luteus* were grown in pure sowings and each in a mixture with *Ornithopus sativus*. The greatest efficiency as a green manure was exhibited by *L. luteus*, both when grown alone but especially in the mixture with *Ornithopus*. Effects upon the subsequent crop of rye are described. (4) Finely ground copper sulphate, 50 kg. per hectare, had a depressing effect upon the yield of *Lupinus luteus* and *Ornithopus sativus* grown as green manure on sandy heathland. It was successful, however, in freeing the subsequent oat crop from the symptoms of " reclamation disease " which ruined the harvest on the control plot. (5) Lupin meal consisting of non-germinable lupin seed was tested for its fertilizer value.

Grassland trials. Hay land. The following experiments, some of which were already of several years' duration, were in progress during 1934. (1) Varying degrees of drainage by means of open ditches of varying depth. The efficacy of drains 0·50 and 0·80 m. deep respectively were compared, the plots between the drains being 30 m. broad. On an average of five years, yield was hardly influenced by the depth of the drain ; only in the wet summer of 1931 was there a marked difference in favour of the deeper drain. (2) Rolling drained high moor meadowland. (3) Comparative trial of basic slag and Algerian phosphates. (4) Trial (in its fourth year) of 30 to 90 kg. N per hectare, applied in different forms. (5) Trial of KP applied at different

times. (6) Two trials, in the eighth and fifth year respectively, of varying doses of KP. (7) Comparative trial, in the first year, of basic slag, Algerian phosphate, and three varieties of bone meal. (8) Trial of farmyard manure, applied at different times. (9) The effect of grazing upon the yield of high moor meadows. (10) Different times of mowing the first cut. (11) Three-year trial of *Phleum pratense* from different sources. The soil was humus sand. Average yield for the three years was highest in the German variety Original Lischow, meadow type, which was closely followed by the Finnish variety Yliniva. In crude protein yield in the first year these two varieties also occupied the first position, although in digestible crude protein the Lischow pasture type took the second place. (12) Long duration liming experiment with varying forms of P_2O_5, in the eighth year.

Grassland trials. Pastures. (1) Comparison of a permanent pasture and a three-paddock, rotationally grazed pasture, 1930–1934. On the latter the animals, two to three-year-old oxen, were moved from one paddock to another approximately every eight days. Average yield for the five years, calculated in kg. live weight increase per hectare, was 3·9 more on the permanent pasture than in the paddocks. (2) Liming of a permanent pasture sown down in 1914. Marl was applied in 1929 at the rate of 20 dz. CaO per hectare. The effect of liming was late in revealing itself, but, although on the limed pasture average live weight increase from 1930 to 1934 is 3·2 kg. per hectare less than on the control, in 1933 there was an increase of 3·3 kg., and in 1934 an increase of 30 kg. on the limed pasture indicated the turning of the scale. Hay yield (one cut taken in 1932) showed 1·57 dz. per hectare increase on the limed land.

In addition to the experiments described above, all of which were conducted on the Königsmoor Experimental Farm, numerous experiments, consisting mainly of manurial trials, have been conducted elsewhere under the aegis of the Bremen Station, of which those in the Weser, Elbe, and North Sea marshes may be mentioned. The question of controlling the poisonous *Equisetum palustre*, of great importance for the extensive marshland regions, is the subject of continued research.

The report for the year 1935 (1st April, 1935, to 31st March, 1936) appears in *Landw. Jb.*, 83. 869–901. 1936. The number of soil, hay, turf, and other samples received for analysis has again mounted by 229, an indication of the increasing attention which is being devoted to the question of nutrient content and especially of lime conditions in the older moorland cultures. A simplified method of making botanical analyses of grassland has been adopted by the Botanical Laboratory under Dr. D. Schroeder.

Although the total rainfall was considerably heavier during the year under review than in the two previous years, its distribution was uneven ; the month of May was unusually dry and characterized by much night frost, often severe, and by east wind, which had a detrimental effect upon the hay crops in particular. In July and August, again, rainfall was considerably below the average for these months and frost occurred as early as September, with disastrous results to the hay aftermath.

A continuation of the comparison of alkaline and acid fertilizers in their effect upon hay leys dressed with varying quantities of CaO more than confirmed previous findings as to the superiority of basic slag over superphosphate. It is recorded that whereas in 1934 the basic slag plot in which acidity was reduced by 80 per cent (dose 64·88 dz. CaO per hectare) formed an exception to this rule, its yield being less than in the corresponding superphosphate plot ; in 1935 its yield was considerably superior to that of any of the other plots, whether basic slag or superphosphate.

Trials of yellow sweet lupins were more successful on sand soil than on high moor, yield being greater by 123·08 dz. per hectare and labour incurred through weed growth being less. Ensilage with the aid of sugar (0·5 per cent) resulted in the production of a palatable and satisfactory fodder.

Grassland trials. Hay land. Many of the experiments listed in the 1934 report were continued. (1) Rolling. In the experiment testing the value of rolling high moor meadows, taking the yield of the unrolled plot as 100, yield in the plot rolled three times annually since 1930 was 144, in the plot rolled twice annually 139, and in the plot rolled once annually it was 121. (2) Liming. A trial of 20, 50, and 80 dz. CaO per hectare combined with tillage to the depth of 15 and 25 cm. respectively, in progress since 1927, shows that, contrary to the original expectation, (*a*) shallower tillage is to be preferred, even in the case of the larger doses of lime ; and (*b*) by the purposely exaggerated 80 dz. dose yield is not only unreduced, but even perceptibly increased. The plots in question were distinguished by greater vigour and a larger proportion of legumes. (3) Deficiency of nutrients. In a trial laid down in 1930 the effect of neglecting the application of K_2O and P_2O_5 respectively is being studied. The figures for 1935 show that, on high moor meadowland, the omission of any kind of potassium leads in a relatively short time to complete failure, even when manurial treatment for many years previously has been normal, but the result of omitting phosphorus is much less rapidly apparent. (4) Nitrogen and compost. The trial has been in progress on high moorland, permanently used for hay, since 1930. The dressings of N amounted to 30, 60, and 90 kg. per hectare respectively. The average increase in yield due to the application of compost was not more than 4·21 dz. per hectare. In percentage of the dry hay the average crude protein content of the compost plots was only 12·83, as compared with 13·88 on the no-compost plots, a fact attributed to the suppression of clover by an increased proportion of grasses and herbs (notably *Taraxacum officinale*). The total average yield of crude protein was the same (5·68 dz. per hectare) with and without compost, but all the N plots exhibited a crude protein yield less on an average by 1·01 or 1·45 dz. per hectare than that of the control receiving no N in the form of mineral fertilizer. One of the main objects of using nitrogenous fertilizers on high moor hay land, namely the increasing of protein yield, is thus unattained.

The following experiments are also in progress : trials of various applications of CaO in the laying down of high moor meadows ; a comparison of basic slag, Algerian phosphates, superphosphate, and a bone meal product on transitional moor meadow ; an experiment to test the effect upon yield (high moor) of alternating use for hay and grazing ; an experiment to compare the effect upon yield of habitual mowing with machine and scythe respectively ; and a new experiment in various methods of laying down new meadowland, with and without the growing of preparatory crops, subsoil liming and manuring, additional organic manuring of different kinds, etc.

Grassland trials. Pastures. (1) In the comparison of permanent pasture and rotationally grazed paddocks for cattle fattening the permanent pasture continued to give superior results in 1935, live weight increase being 7 kg. per hectare more than in the paddocks. (2) A comparison of the same quantity of potassium salts and basic slag applied to paddocks annually and every other year respectively showed the greater advantage of annual dressings, as follows : greater live weight increase ; in 1935, 9 kg. per hectare ; average greater increase for the years 1930 to 1934, 5·6 kg. per hectare. (3) Liming of a permanent pasture sown down in 1914. The beneficial effects of applying marl in 1929, which were first evident in 1934, were still more clearly reflected in 1935 in the increased vigour of the herbage and better growth of *Trifolium repens*, in spite of cold, unfavourable weather conditions in spring. The improved sward necessitated heavier stocking, and an augmentation of live weight increase by 174 kg. per hectare is recorded. The experiment continues.

Experiments at Aschwarden in the ensilage of *Equisetum palustre* have shown that only hot fermentation by means of the Dutch stack process is successful in destroying the poisonous principle of this plant.

KIEL, Preussische Versuchs- und Forschungsanstalt für Milchwirtschaft. [**Prussian Dairy Research Station.**] Report by the Director, Professor Mohr, and the Heads of the various Institutes.

The Report covers the period 1st April, 1935, to 31st March, 1936, and appears in *Landw. Jb.*, 83. 783–828. 1936.

The Station, which is comprised of eight institutes, has been enlarged during the year by the incorporation in the Institute of Forage Crop Production of what was formerly the Crop Production Institute of the University of Kiel, with its land and library, and by the acquisition of an additional experiment farm of approximately 600 hectares.

Professor Buenger is appointed Director of the Station for two years from 1st April, 1936.

Institut für Futterbau. [**Institute for Forage Crop Production.**]

Breeding work in connexion with the following crops, among others, was in progress : grasses (for fodder value and yield, pasture, meadow, and temporary ley types) ; clover (for persistence, fodder value and yield, immunity to rot) ; lucerne (for a type adapted to a maritime climate) ; marrow stem kale (for productivity, winterhardiness, and leafiness and good stem formation respectively).

Scientific research preparatory to breeding included the following subjects : the protein content of cereals and forage plants as a modifiable and variable quantity ; the principles of breeding clover for immunity to rot ; breeding for immunity to the so-called " reclamation " disease and grey leaf ; seed production technique in regard to herbage and forage plants.

In research concerned with the growing of crops, the most important place is given to forage plants. The following studies are enumerated : comparison of the agricultural and fodder value of the principal protein-supplying plants; the value of different forage plants in rotations as (*a*) the principal crop, (*b*) catch crops ; variety trials of marrow stem kale for productivity and form of cultivation and utilization ; trials of the Landsberg mixture (*Trifolium incarnatum, Vicia villosa* and *Lolium italicum*) ; sweet lupin trials ; the utilization of potato and turnip tops ; the effect of cover crops upon sowings of lucerne, clover, and clover-grass mixtures ; soybean trials ; the " reclamation disease " problem ; long duration trials of different potassium fertilizers on sandy heathland soils ; and long duration trials of various forms of N, P, and K on high moor mown pastures, with special reference to the conditions of Schleswig-Holstein.

POLLINATION AND SEED SETTING OF RED CLOVER.

FIVE papers on this topic were read at the Fifth Congress of the "Nordiske Jordbrugsforskeres Forening" held in Copenhagen on July 3–6, 1935 (*Herb. Rev.* 4. 95–6. 1936). Details will be found at the end of this review. The second article in the series, by Valle, Finland, has already been reprinted in translated form in *Herb. Rev.* 4. 71–7. 1936. Translations of all five articles are available on request.

Sylvén discussed some of the factors which influence seed setting. The main essential in Sweden is the selection of a clover strain suited to the particular conditions. Sunshine combined with appropriate moisture constitutes the most favourable weather for seed setting. A long period of heat with extremely dry air during flowering is harmful. Although certain biotypes of the species are distinguished by a surprising degree of self-fertility, *Trifolium pratense* is to be regarded as a normally cross-fertilizing plant, and good care must therefore be taken to ensure that conditions (supply of insects and good weather) favour cross-fertilization. In addition to humble bees, honey bees are very efficient flower visitors, especially in respect of strains with slightly shorter corolla tubes.

A question which has recently aroused the interest of South Swedish clover seed growers has been the possibility of inducing better seed setting in the aftermath (second generation of shoots) by early cutting in the spring; this applies more particularly to the seed yield of early types.

One of the most serious obstacles to Swedish clover seed production is the susceptibility of red clover to attack by *Sclerotinia trifoliorum* and *Tylenchus devastatrix*.

Wexelsen states that seed production of red clover in Norway has always been regarded as a difficult and uncertain cultivation, yields being small and fluctuating and quality of seed variable. The paper is based upon the author's work at Vidarshov, Vang, Hedmark, which was made on seed plots chosen from ordinary clover-timothy meadows and also in the field with single plants.

As a result of a hereditary variation in earliness, the clover strains have a long flowering period; individual plants also show fairly extended flowering. Pollination in wet weather or in wet flowers is useless. The percentage of good pollen may vary from 0 to 100, due chiefly to chromosomal abnormalities, but possibly also to heritable factors or to the environment. Red clover is highly self-sterile and cross-pollination is therefore necessary for fertilization; this is carried out almost exclusively by humble bees and honey bees. The remainder of Wexelsen's article is considered with observations on the relative efficiency of these two pollinating agents.

Valle's article on pollination and seed formation of the clover species has already been published in full (*Herb. Rev.* 4. 71–7. 1936); observations were made regarding insects which visited flowers of red, alsike and white clover during the flowering period.

At a meeting of the same organization (N.J.F.) held in 1933, Pedersen gave an account of some of the early investigations conducted by him in the Department of Agricultural Plant Cultivation of the Agricultural College of Denmark. The present paper contains a brief summary of these investigations, continued in collaboration with Dr. K. Dorph-Petersen, Director of the Danish Seed Testing Station, on the pollination conditions and the attacks of *Apion* sp. in a large number of red clover seed fields. Particular attention was paid to early red clover as the cultivation of this type has proved difficult in Denmark. Regular counts were made of bee visits,

that is, the number of bees, the species and method of working, on a marked area about 300 to 400 sq. metres in size, generally every second or third day during the flowering period ; attack by *Apion* was determined by investigation of samples of clover heads. Observations were made on positive and negative bees, length of corolla tubes (early clover has longer tubes than late), height of nectar, etc.

The distribution of *Apion* attack was investigated in several fields but it was found to be uniformly distributed, so that sampling of one area only is sufficient. The attack on early and late red clover was practically identical when flowering occurred simultaneously. The attack extended over the whole flowering period, but was generally most severe at the beginning of that period and declined subsequently, at first slowly and later sharply during the last part of the flowering period.

Stapel's paper was concerned entirely with the bee situation in connexion with red clover pollination. One of the most important results as far as Denmark is concerned is the fact that Italian bees visit red clover more frequently than Danish bees ; it is stated that this fact has not been observed previously because a method of deciding what plants are visited by the bees has been lacking. The pollen analysis method used here gives, if one confines oneself to pollen collectors, a distinct and reliable answer to this question. The Danish seed grower would be well advised to keep bees himself and should choose Italian bees ; by increasing the brood in the hives he will promote pollen collecting at the cost of nectar collecting, which more easily leads to robbery.

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ALFALFA SEED INVESTIGATIONS IN UTAH.

[Reviewer: J. H. WESTERN.]

ALFALFA was first planted near the shores of Utah Lake in 1860, but as seed-growing increased in commercial importance the industry became concentrated in a few counties of central and eastern Utah. The peak of production for the state was reached in 1925 when approximately 441,600 bushels of *Medicago* seed were grown. Of this amount 294,000 bushels were produced in Millard County and 147,000 bushels in the Uintah Basin. Since 1925 the yields of alfalfa seed have declined, and in 1932 only 18,000 bushels were harvested in the whole of the state. Although this decline is partly explained by the reduction of the alfalfa acreage, the yield per acre has also shown a downward trend since it averaged 1·2 bushels in 1930, as compared with 6 to 8 bushels in 1925. The cause of low yields has been the subject of research at the Uintah Basin Alfalfa Seed Experimental Farm. The results of the investigations are recorded in the first paper under review.*

The influence of climatic conditions upon the production of alfalfa seed is discussed. The regions most successful in alfalfa seed raising have been those with an annual precipitation of from 5 to 13 inches, but under these conditions some irrigation is usually necessary. The summer precipitation in Utah is uniformly low, except on the mountain ranges, but light showers are of frequent occurrence, and these, with the alternation of clear and cloudy weather, are regarded as important factors in alfalfa seed setting. The low precipitation is believed to condition the atmosphere, rather than the soil, for seed growing, since additional irrigation or ground water is usually required for a successful crop. In the Uintah Basin observations, continued over a period of years, showed that severe stripping of flowers (i.e. the falling of flowers through failure to set seeds) often occurs as the result of prolonged sultry weather, particularly in July and August. Alfalfa flowers were marked and counted and the percentage calculated of those forming seed pods, under varying conditions of air temperature and relative humidity, recorded by a hygrothermograph. It was concluded that a relatively low mean moisture content of the air, with a high degree of variability or frequent fluctuations, is associated with good seed setting in alfalfa.

Data concerning the mean temperatures of ten day periods during the flowering seasons from 1929 to 1934, suggest that changes in the temperature have not been a factor of any considerable importance in causing alfalfa-seed crop failures in Utah. In general, an atmosphere with a fairly low average relative humidity favours seed setting while, it is suggested, a high degree of variability would produce frequent changes in the degree of turgidity and flaccidity in the flowers and would thus increase the probability of attaining a degree of moisture conducive to pollen germination and flower fertilization.

On the average from 30 to 50 per cent of the alfalfa flowers form seed pods in years when a good harvest results. If the percentage of setting falls as low as 15 or 20 per cent, the crop is not profitable, while a failure is almost certain when the setting falls to 5 or 10 per cent. From six to eight successive crops of flowers are produced in a normal season in the Uintah Basin, seed setting being usually highest with the first three and the last crops. The aggregate of seed, resulting from less than one half of the flowers of each crop, often constitutes yields ranging from 600 to 1,000 lb. per acre. Seed setting is noticeably poorest during the mid-season (approximately from July 15 to August 15). As individual flowers increase in age their capacity

* Utah Agricultural Experiment Station. Bull. 258. Alfalfa seed investigations in Utah. By John W. Carlson. 1935. pp. 48.

to form seed pods decreases and many flowers are lost through stripping which is caused, apparently, by the prevention of pollination and fertilization through unfavourable weather conditions.

In addition to stripping, "bud-blasting," a condition which results, in part, from injury caused by Lygus bugs, is also responsible for severe losses, especially in thick stands of alfalfa.

Stripping and bud-blasting often occur on the same plant and, in some seasons, their combined effect may result in the crop becoming a complete failure. It is suggested that the effects of meteorological conditions on the activities of insects should be studied as information on this subject might lead to a fuller understanding of the causes involved in alfalfa seed crop failures.

A comparison was made of the efficiency of different methods of flower pollination with respect to the production of seed pods. It was found that 27 per cent of the flowers allowed to develop naturally formed seed pods as compared with 44 per cent of those tripped artificially and 54 per cent of those artificially cross-pollinated. By artificially tripping, or cross-pollinating, and then enclosing the flowers in kraft bags for protection against Lygus bugs, seed setting in mid-season and on flowers of second-crop alfalfa was equal to that on similarly treated early-season flowers of the first crop. Similar flowers, when left exposed to open field conditions, gave a lower percentage of pods.

The effects of open and self-pollination on seed yields in plant progenies were investigated. Reducing yields were obtained from plots sown with the progeny of inbred seeds, the reduction equalling approximately 50 per cent of the yields from the progeny of open-pollinated seeds from the same plant. A partial recovery in the yield of plants derived from the seed set by open-pollinated flowers of inbred plants is thought to be due to hybrid vigour resulting from cross pollination in the field. This vigour is expressed by an improved production of seed pods, a greater proportion of seed pods maturing and, lastly, a larger number of seeds per pod.

The effect of the rate of seeding upon the thickness of the resulting stand and upon the yield of seed obtained was studied. Alfalfa stands, which varied from thin to very thick, were secured by sowing from two to nine lb. of seed per acre. The thickness of the stand was, however, conditioned also by factors other than the seeding rate. A comparison was made of the stands resulting from three methods of sowing, namely, hill-spaced, row-spaced and ordinary light drilling. On the average the results obtained by these three methods were superior, in that they gave higher yields of seed per acre, to ordinary drilling at a heavier seed rate. For seed production in especially favourable years, however, thick stands may prove equally as good as the thinner ones. The disadvantage of thick stands in many seasons appears to be that they encourage the multiplication of the Lygus bugs, and other injurious insects, which damage the flowers and so reduce the amount of seed set.

Seed production with alfalfa varieties, and especially with strains within varieties, has been found to differ greatly. Varieties and strains show a marked difference in response to insect injury, as is evidenced by the relatively high yields of heavy seeding strains adjacent to other varieties showing severe bud-blasting, with resulting low seed yields.

Certain families of alfalfa plants, obtained from the seed produced from open-pollinated flowers on selected single plants, showed outstanding seeding capacity in a preliminary series of trials. They were, therefore, included in more extensive seed-production tests in 1934. Several strains of the Turkestan variety of alfalfa were also grown since they appeared to possess resistance to the wilt disease.

Significant variations in yield between some of the varieties and strains were observed, but many of the common commercial varieties of alfalfa proved of approximately equal seeding capacity. In general, the varieties and strains which had given high yields in the previous tests maintained their superiority in the more extensive trials of 1934. The majority of the common commercial varieties, and selections from these, composed an intermediate group between the high seed producing strains and a low yielding class comprising strains of Turkestan and the ordinary Ontario Variegated.

As a general rule, the principal source of variation in yields of forage from alfalfa varieties and strains is due to seasonal influences. Varieties which are high in forage production at one station for one year are usually high in other places the same year. Exceptions do occur, however, and it may be possible to find varieties especially adapted for particular conditions.

Concurrently with the investigations at Uintah Basin, similar work was carried out in the Delta Area of Millard County, Utah.* In this instance alfalfa seed production on a number of ordinary farms was studied with results similar to those reported from the Experimental Station at Fort Duchesne.

The best yields were obtained when the water supply was somewhat limited but sufficient to enable the plants to function properly during the blooming and seed farming periods. Optimum seed production was obtained after the first crop had been cut early at the bud stage, or pastured with spring lambs until the middle of May. Leaving the first crop for seed is not considered economical as the hay is more valuable than the increased yield of seed. The practice of growing alfalfa in hills or rows, while not conducive to bumper crops, will in most years ensure an amount of seed sufficient to show a profit. The decrease in alfalfa seed yields in Utah during recent years appears to be due to a number of factors, none of which alone is sufficiently outstanding to be considered the chief cause of the decline. Seed production is influenced by climate and weather, soil properties, both chemical and physical, the prevalence of harmful insects and the methods employed to harvest the crop. With regard to harvesting, it is recommended that the seed should be gathered when the majority of the burs have turned brown but before they are black.

The opinion is expressed that much can be done to prevent alfalfa seed production failures by a judiciously planned selecting and breeding programme.

* Utah Agricultural Experiment Station. Bull. 268. Alfalfa seed investigations and other crop varietal studies. Millard County, Utah, 1929 to 1933. By G. Whornham. 1936. pp. 24

THE WESTERN RANGE.

"THERE is perhaps no darker chapter nor darker tragedy in the history of land occupancy and use in the United States than the story of the western range," which unexpectedly and almost overnight "became the potential source of great wealth from livestock grazing. All the major findings which constitute the first part of this discussion* have their origin in the effort to capitalize this wealth and convert it to human use."

In the letter of transmittal from the Chief of the United States Forest Service to the Secretary of Agriculture, it is stated that the Report incorporates information obtained by many years of research on the range and watershed problems, by special surveys which have been under way for several years and by 30 years' administration of the national forests. It includes the pertinent information now available in the Forest Service and that which could be obtained from other Federal and State agencies.

One of the primary reasons for this neglect, and hence the serious depletion of the range resource and a series of major maladjustments in land use, has been a division of responsibility among public agencies. If the Federal government is to redeem its responsibilities, one of the first and most important needs is, therefore, the concentration of responsibility in a single Federal department. Since the problem is wholly agricultural, this concentration must be in the Department of Agriculture.

As such a comprehensive publication cannot be reviewed satisfactorily in the space at our disposal, it will perhaps be sufficient to say that the Herbage Bureau hopes to be able to include in the next issue of *Herbage Reviews* an article from a member of the United States Forest Service on the present position of range management research in the United States.

In the meantime, a repetition of the "high lights" stated in the publication under review is made.

1. The range area of 728 million acres is nearly 40 per cent of the total land area of the continental United States; more than 99 per cent is available for livestock grazing.

2. About half the range areas, or 376 million acres, is in private ownership. One-third, or 239 million acres, is Federal range, divided among national forests, grazing districts, public domain, and other withdrawals and reservations.

3. Forage depletion for the entire range area averages more than half; the result of a few decades of livestock grazing.

4. Range depletion on the public domain and grazing districts averages 67 per cent, on private, Indian, and State and county lands about half, and on national forests 30 per cent.

5. Three-fourths of the entire range area has declined during the last 30 years, and only 16 per cent has improved.

6. During the same period 95 per cent of the public domain and grazing districts has gone downgrade and only 2 per cent has improved. For other forms of ownership and control corresponding figures are: Private lands 85 and 10, State and county lands 88 and 7, Indian lands 75 and 10, national forests 5 and 77.

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* United States, Dept. Agric., Forest Service. 74th Congress. 2nd Session. Doc. No. 199, The Western Range. Letter from the Secretary of Agriculture transmitting in response to Senate resolution No. 289 a report on the Western Range—a great but neglected natural resource. 1936. pp. 636.

7. Only about 95 million acres of the entire range area are in reasonably satisfactory condition. Nearly half of the national forest range and 12 per cent of private ownership fall in this category. The reasonably satisfactory areas in other ownerships are inconsequential. Probably not much over 5 per cent of the entire range area is in a thoroughly satisfactory condition.

8. An outstanding cause of range depletion has been excessive stocking. Some 17·3 million animal units are now grazed on ranges which it is estimated can carry only 10·8 million. The removal of the surplus is the most effective way to stop depletion and start the range on the upgrade.

9. About seven-tenths, or 523 million acres, of the range area is still subject to practically unrestricted grazing.

10. Precipitation in the range country averages less than one-third of that of the Middle West and East. One to 4 drought years out of 10 characterize practically all of the range area. The failure to recognize in stocking the wide and direct fluctuation of forage production with precipitation has been one primary cause of depletion.

11. Among financial handicaps to the range livestock producer, possibly the most serious is the marketing differential, mainly freight, which for Idaho is nearly $8·50 for a 1,100-pound steer in the Chicago market as compared with Illinois.

12. The one best answer to this and other financial handicaps is cheap range feed, which costs only one-fifth to one-tenth as much as hay or other supplemental feed. But serious depletion of range feed has been practically universal, and heavy supplemental feeding has been necessary.

13. Unsuitable land laws and policies have made the range a bewildering mosaic of different kinds of ownerships and of uneconomic units, which together constitute a serious obstacle to range management and profitable livestock production.

14. Range livestock production was once almost wholly pastoral. Thirty-five per cent of the feed for western livestock is now supplemental feeds raised on crop lands or irrigated pastures—a threefold increase in 45 years. Except for highly specialized crop farming, mostly on irrigated land, western agriculture is now primarily an integration of range livestock grazing and crop farming.

15. Excluding irrigation improvements, the 1930 census values farm lands and buildings, privately owned range lands, and farm and range livestock, etc., at nearly 12·9 billion dollars.

16. Most spectacular among the maladjustments of range-land use has been the attempt to use more than 50 million acres for dry land farming. About half, ruined for forage production for years to come, has already been abandoned for cultivation, much of it even before going to patent.

17. A more serious but less spectacular maladjustment has been the private acquisition of many million acres, either submarginal for private ownership as shown by high tax delinquency and relief rolls, abandonment, etc., or having high public values for watershed protection which private owners cannot maintain, or both.

18. Four-fifths of the 232 million acres which yield 85 per cent of the water of the major western streams is range land and low precipitation makes water the limiting factor in nearly all western development.

19. No less than 589 million acres of range land are eroding more or less seriously, reducing soil productivity and impairing watershed services. Three-fifths of this area is adding to the silt load of major western streams.

20. It will probably require more than 50 years of management to restore the depleted range sufficiently to carry even the 17·3 million livestock units now grazed, and probably an additional 50 years to restore it to the nearest possible approach to its original grazing capacity of 22·5 million units.

21. Action of greatest immediate urgency and importance is to :

Stop soil and forage depletion, and start both on the upgrade ;

Reduce excessive stocking, place all range lands under management, and restore cheap range feed ;

Rectify land ownership and use maladjustments, and obtain a sound distribution of ownership between private and public agencies ;

Build up economic private and public units ;

Balance and integrate crop and range use ;

Correlate the livestock, watershed, forest, wild life and recreation forms of range land uses and services ;

Obtain a recognition of the responsibility of stewardship by private owners

Minimize or remove various financial handicaps of stock producers ;

Reconcile range conservation and the financial needs of State institutions ;

Solve the tax delinquency problem ;

Place public lands under the supervision of agricultural agencies as a step towards unification of public responsibility for the entire problem. Provide on such lands for a sound distribution of grazing privileges, and prevent the establishment of prescriptive rights ;

Obtain and apply the information necessary for the conservation and wise use of the range resource ;

Prevent human wastage and insure social and economic security.

CONFERENCES.

CALCUTTA, 1935.

The Proceedings of the Twenty-second Indian Science Congress, held in Calcutta in January, 1935, have been received.

The following are some of the papers of interest ; abstracts only of these papers are given. The subject matter of each will be dealt with in *Herb. Abstr.*, Vol. 7, No. 1, 1937.

Narayanaswami, V. Preliminary revision of the Gramineae of India. Page 261.

Samal, K. K. The development of the embryo-sac and embryo in *Crotalaria juncea* L. Page 262.

Samal, K. K., and Banerji, I. Microsporogenesis in *Crotalaria juncea* L. Page 263.

Banerji, I. Embryology of *Arachis hypogea* L. Page 263.

Ranjan, Shri. Studies on photochemical action in plant respiration. Page 274.

Bari, M. Abdul, and Salam, M. Abdus. Influence of nutrition on sexual expression in maize. Page 275.

Shaw, F. J. F. Indian agriculture and plant breeding. Page 341.

Bose, S. S., and Gupta, S. C. Sen. A study in co-variance with fodder crops. Page 347.

Mahalanobis, P. C., and Bose, S. S. A note on the application of multiple correlation for estimating the individual digestibilities of a mixed feed. Page 348.

Bose, S. S., Menon, T. V. G., and Mahalanobis, P. C. A statistical study of the yield under permanent manurials in Pusa. Page 348.

Menon, T. V. G., Bose, S. S., and Mahalanobis, P. C. A statistical study of soil-deterioration in the permanent manurial experiments in Pusa. Page 348.

Vaidyanathan, M. A statistical study of results of Cawnpore permanent manurial experiments. Page 349.

Joshi, N. V. A study of the changes in the bacterial flora of different silages. Page 355.

Khanna, K. L. Factors controlling nodule development in groundnut (*Arachis hypogaea*) sannhemp (*Crotalaria juncea*) and "Dhaincha" (*Sesbania aculeata*). Page 359.

Alam, M. A genetical analysis of *Cicer arietinum* (gram). Page 369.

Singh, T. C. N. Studies in the pulses of Bihar and Orissa–1 (Rahar). Page 370.

Sengupta, D. M. *Paspalum dilatatum* Poir—a promising exotic grass for Assam. Page 371.

Mitra, M. A new blight disease of gram. Page 374.

Luthra, J. C., Sattar, Abdus, and Bedi, K. S. Life history of gram blight, *Ascochyta rabiei* (Pass) Lab=*Phyllosticta rabiei* (Pass) Trotter and measures for its control. Page 373.

Iyer, A. Viswanatha. Minerals in pasture grasses. Page 379.

Bal, D. V., and Athawale, C. R. An investigation into the effect of manuring and stage of maturity on the yield and mineral composition of pasture grass and their bearing on the mineral requirements of the cattle of the Central Provinces. Page 380.

Tambe, G. C., Nagar, C., Krishnamoorthi, T. The provision of succulent fodder for work cattle in Central India. Page 381.

Rege, R. D., and Wagle, P. V. A simple method to estimate the wilting stage. Page 383.

The Twenty-fourth Congress is to be held in Hyderabad (Deccan) from January 2 to 8, 1937.

AMSTERDAM, 1935.

The following is a list of those papers read at the Sixth International Botanical Congress in September, 1935, which are of interest to readers of the Herbage Publications. Bibliographical details and brief abstracts of the majority of these will be found in *Herb. Abstr.*, Vol. 6, No. 4, 1936.

Kögl, F., Investigations on growth substance of plants. Vol. 1. (97–107.)
Becking, L. G. M. B. The Zuiderzee, its past, present and future. (108–21.)
Loehwing, W. F. Interactions between different plants through their roots. (139–45.)
Rasmusson, J. Some inbreeding problems. (181–5.)
Stojanoff, N. On the species conception, and views in modern systematics. (185–8.)
Sprague, T. A. Report on nomenclature. (333–69.)
Russell, Sir E. J. The growing plant : its action on the soil and on its neighbours. Vol. 2. (1–3.)
Brenchley, Winifred E. The weed flora in its relation to crop and agricultural treatment. (5–7.)
Volkart, A. Weed flora in its dependence on soil dispersion, structure and associated characters. (7–8.)
Stapledon, R. G. The biotic factor and the instability of grassland associations. (8–10.)
Regel, C. Formation and composition (associations) of natural and artificial meadows in North Europe. (10–3.)
Klapp, E. Utilization of grassland associations for agricultural purposes. (13–5.)
Scarth, G. W. Colloidal changes in protoplasm associated with hardening against frost. (41.)
Tischler, G. The importance of polyploidy for problems in plant geography. (54–6.)
Muentzing, A., Turesson, G., and Tedin, O. The species concept in the light of modern research. (56–7.)
Turrill, W. B. Some aspects of experimental taxonomy. (57–8.)
Watt, A. S. Some climax associations of Great Britain. (66–8.)
Conard, H. S. The composition and spatial relations of the vegetation of north-eastern North America. (69–70.)
Schmid, E. The mapping of oecogenetical units of vegetation. (76–7.)
Podpěra, J. A comparison between the Steppes of Central Europe and Russia. (84–6.)
Keller, B. A. Dynamic ecology. (Some main problems and principles of plant ecology in U.S.S.R.). (112–4.)
Hutchinson, J. A new phylogenetic classification of monocotyledons. (129–31.)
Wilbrink, G. The need of uniform terms in plant immunology. (204–6.)
Boening, K. The effect of mineral salt nutrition on the susceptibility of plants to attack by parasites. (210–2.)
Fitting, H. Hormones as physiological stimulants. (267.)
Went, F. W. Hormones involved in root formation. The phenomenon of inhibition. (267–9.)
Snow, R. Substances causing cambial growth. (269.)
Brauner L. The problem of tranverse movement of growth substance through tropistic stimulation. (269–71.)
Cholodny, N. Seed hormones and germination. (271–2).
Soeding, H. Is growth substance non-specific? (272–3.)
Virtanen, A. I. Amino-acid synthesis in the plant. (275–6.)
Becquerel, P. Latent life in seeds and spores. (279–81.)

MOSCOW, 1936.

The Agrostological Conference arranged by the U.S.S.R. Research Institute of Fodders, Kachalkino, was held in Moscow from January 1 to 13, 1936, when 43 papers were presented at the various sessions (reviewed by T. Rabotnov in *Bot. Ž. U.S.S.R.*, 21. 258–60. 1936.)

In the first group of papers dealing with experimental work in various farms and with the conversion of woodlands into meadows and pastures, the following points were stressed :

(1) The grey alder trees had a more favourable effect on the grass stands than

birch or aspen (Mednis and D. Ivanov), a fact which the former author traced to a symbiosis of alders with nitrogen-fixing organisms.

(2) The marked increase in yield of grassland was due to top-dressing with organic residues, such as stable manure, potato tops, straw, and other farm by-products ; the same effect could be obtained by frequent changing of the location of the resting pastures (Mednis, Minina, Pridanceva, Mihaïlovskaja, and Miheev).

The formation of aftermath was discussed in the report of Larin supplemented by those of Tužihin, Mihailov, and Nikitina, from which it was evident that comprehensive data on the study of aftermaths of various plants and phytocoenosis have been collected for the last ten years in various parts of the Union. These data are of considerable importance in rationalizing the systems of grazing and feeding. Previous investigations were mostly empirical, without regard to the theoretical bases. It was felt to be particularly necessary to attack the problem with reference to Lysenko's theory of phasic development, as well as to root studies, variability of plastic substances, etc.

The third group of papers was devoted to some indigenous herbage plants.

(1) Begučev has found that *Kochia prostrata* is a polymorphic species, and can be divided into a number of species, of which *K. prostrata sabulosa*, typical of sandy soils, is of high fodder value. The main defect of this species is the rapid loss of seed germinability ; after twelve months the germination falls to 3 to 4 per cent. Low germinability could be traced to increased moisture content (21 to 22 per cent). Storage of seed under a layer of calcium chloride maintained the germinability unchanged for a year.

(2) Anfinogenov reported a study of the fodder value of *Scirpus maritimus*, *Butomus umbellatus*, and *Sagittaria sagittifolia*, the tubers and roots of which (particularly those of *Sagittaria*) contain more nutrients than potato and topinambour (*Helianthus tuberosus*).

(3) Pelot summarized the results of studying seasonal variation in yield and quality of fodder in *Artemisia maritima*, *Glycyrrhiza glabra*, *Alhagi camelorum*, and *Phragmites communis*.

(4) Sinicyn reported on the biology of *Stipa capillata*, one of the most persistent weeds on the steppe pastures in North Caucasus. Burning, harrowing, and disking merely resulted in vigorous development, and autumn grazing or cutting when in ear appeared to be the only means of checking the weed.

(5) Mesner reported on the control of *Rumex confertus* and *Allium angulosum*, common weeds on flooded lands. Cutting the roots at a depth of 7 to 10 cm. was the most effective method of checking *Rumex*.

(6) Data on the chemical composition and palatability of wintersome herbage were given by Davydova and Sverkunov ; this herbage is of considerable fodder value, not inferior to average quality hay.

A number of papers dealt with the rationalized systems for combined use of grassland for hay and pasture, spring grazing, etc.

In the session dealing with the improvement and laying down of grassland, Dmitriev delivered an address on the practice, theory, and study of grass mixtures. After criticizing the present empirical methods, the author stressed the following points :

(1) The mixture must have a strictly defined purpose, such as hay, pasture, short-duration ley, etc.

(2) The mixture must be simple.

(3) The plants in the mixture must deposit in the growing season sufficient organic substances to maintain a stable soil structure.

(4) The mixture must ensure the fullest possible use of the lower soil layers and the transport of nutrients to the upper layers.

(5) The mixture must be a " biological entity," composed of " normally compatible " plants, or those " normally competing," and must not contain " antagonistic plants."

(6) It is inadvisable to use short grasses ; mixtures should be restricted to those suitable for short duration (4 to 5 year) leys.

The fertilization of grassland and the laying down of meadows on marsh lands were among other topics discussed.

In the session dealing with haymaking, the adverse effect of early cutting on the yield of the subsequent year was reported by Meljnikov, Loginov, and Miheev. Andreev reported that in a three-year's test the highest yield from various types of grassland was obtained by cutting at a height of 4 cm.

Finally, two reports were delivered by Šennikov on the study of natural forage lands and species being made by the Botanical Institute of the Academy of Sciences in U.S.S.R.—M.A.O.

NETHERLANDS, 1936.

The International Congress of Plant Breeders was held in Holland on June 22 to 27, 1936. The Report is edited by Dr. M. J. Sirks, Instituut voor Plantenveredeling, Wageningen, and published by E. J. Brill, of Leiden. The organization and scope of plant breeding in many countries of the world are fully discussed. Abstracts of many of the papers have appeared in *Herb. Abst.* 6, No. 4, 1936.

OXFORD, 1937.

A Second Conference on Mechanized Farming is to be held at Rhodes House, Oxford, on January 5 to 8, 1937, under the joint auspices of the School of Rural Economy, the Agricultural Economics Research Institute and the Institute for Research in Agricultural Engineering of the University of Oxford.

Of particular interest to the readers of Herbage Publications is the discussion on the artificial drying of grass to be held on Thursday, January 7, when the following papers will be read :

E. J. Roberts. A year's progress in grass drying.
A. G. Bazley, J. E. Chambers, and R. Vaughan-Williams. Practical experiences with grass-drying equipment.
R. N. Dixey, and R. P. Askew. The production of dried grass and its cost.
J. A. S. Watson. Some speculations as to the future of grass drying.

A report of the Conference will appear in *Farm and Machine*, Vol. 4, 1937.

ABERYSTWYTH, 1937.

The Fourth International Grassland Congress is to be held in Great Britain in July, 1937, under the Presidency of Professor R. G. Stapledon, C.B.E., M.A., Director of the Welsh Plant Breeding Station and of the Imperial Bureau of Plant Genetics : Herbage Plants, Aberystwyth, Wales.

The Congress is to be held in collaboration with Der Vereinigung Internationaler Grünlandkongress (the International Grassland Congress Association), which has its central office in Leipzig, Germany (Secretary, Dr. Richard Geith).

Three Congresses have been held in other countries ; the first was in Germany in 1927, and the second in Sweden and Denmark in 1930 under the title of "Conference of Grassland Farmers from Northern and Central European Countries." The third Congress was held in Switzerland in 1934 under the title of "Third Grassland Congress of the North and Central European Countries." Subsequent to the third Conference at Zürich, the International Grassland Congress Association was formed with the object of carrying on the work of the Congress from one meeting to another. At Zürich also an invitation was presented by the British delegation, asking that the fourth Congress might come to Great Britain in 1937.

The fourth Congress will be more extensive than the earlier Congresses, as specialists from the British Dominions and Colonies, the United States of America, and numerous other countries outside Europe are being invited to take this opportunity of meeting prominent British and European investigators.

PLAN OF CONGRESS.

The paper-reading sessions will be held in Aberystwyth, on July 15 to 18, 1937. Intending participants will be invited to join in a tour of centres of grassland interest both before and after these sessions. The tour will be made partly by motor coach and partly by rail. Four options will be available for selection :—

		July.
(1)	Attending paper-reading sessions and local Aberystwyth tours only	13–19
(2)	Assembling at Oxford, proceeding via selected centres of grassland interest to Aberystwyth, and participating in sessions and local tours	8–19
(3)	Attending paper-reading sessions and local tours, and proceeding from Aberystwyth to Newcastle and Edinburgh, where disperse ..	13–23
(4)	Assembling at Oxford, proceeding to Aberystwyth, attending paper-reading sessions, and local tours, and proceeding thence to Edinburgh, i.e., the whole tour, of which options 1, 2, and 3 are only parts	8–23

ITINERARY.

Date.	Programme.	Night accommodation at
July, 1937.		
Thursday, 8 ..	2 *to* 5 *p.m.*: Enrolment of delegates at Oxford. Sight-seeing during afternoon.	Oxford.
Friday, 9 ..	Local excursions and demonstrations of grassland implements.	Oxford.
Saturday, 10 ..	*Morning*: Leave Oxford for Rothamsted Experimental Station. *Afternoon:* Leave Rothamsted for Leicester, visiting Northampton Institute of Agriculture en route.	Leicester.
Sunday, 11 ..	Leicestershire pastures.	Birmingham.
Monday, 12 ..	Visit farms on route via Stratford-on-Avon, Stow-on-the-Wold and Northleach, to Royal Agricultural College, Cirencester.	Cirencester.
Tuesday, 13 ..	Leave Cirencester for Gloucester and Hereford. Seed production areas and farms of interest en route.	Hereford.

ITINERARY—*continued.*

Date.	Programme.	Night accommodation at
July, 1937.		
Wednesday, 14	Delegates taking options 2 and 4 proceed from Hereford to Cahn Hill Improvement Scheme. Delegates taking Options 1 and 3 enrol at Agricultural Buildings, Aberystwyth, from 10.0 a.m. onwards. 12 *noon:* Proceed to Cahn Hill Improvement Scheme to connect with those coming from Oxford on Options 2 and 4.	Aberystwyth.
Thursday, 15	Brief address of welcome. *Morning:* First Session (plenary). *Afternoon:* Welsh Plant Breeding Station or local tours.	Aberystwyth.
Friday, 16 ..	*Morning:* Second Session (sectionalized). *Afternoon:* Third Session (short sectionalized session). *Evening:* Meeting of the International Grassland Congress Association (to be arranged by Dr. R. Geith).	Aberystwyth.
Saturday, 17 ..	*Morning:* Fourth Session (plenary). *Afternoon:* Fifth Session (plenary). *Evening:* Final meeting and formal dissolution of Congress.	Aberystwyth.
Sunday, 18 ..	Welsh Plant Breeding Station or local tours. *Evening:* Leave Aberystwyth for Shrewsbury and Newcastle.	In train.
Monday, 19 ..	Arrive Newcastle. Visit County (Northumberland) Agricultural Experiment Station at Cockle Park.	Newcastle.
Tuesday, 20 ..	Visits to farms and grassland in Northumberland.	Newcastle.
Wednesday, 21	Leave Newcastle for Edinburgh. Visit Boghall (Edinburgh and East of Scotland College of Agriculture) or Corstorphine (Scottish Society for Research in Plant Breeding).	Edinburgh.
Thursday, 22	Tour through Central Plain, southern part of Central Highlands and Trossachs.	Edinburgh.
Friday, 23 ..	Sight-seeing in Edinburgh.	

Certain evening and other entertainments are to be arranged. Details will be circulated later.

THE TOURS.

The tours have been so arranged that participants will have an opportunity to see something of British grassland farming, including livestock management, over as wide a range as possible. The limits to what can be done have been set by the amount of time available, and the obvious necessity for curtailing charges to delegates.

In the section Oxford and its neighbourhood, visits will be made to centres representative of the South England Downs and the Thames Valley. The tour proceeds through Rothamsted to Northamptonshire and Leicestershire, where opportunity will be presented to visit some of the best fattening pastures in England. On Monday, July 12, farms of special interest in Warwickshire and Gloucestershire will be visited, which include modern dairy farms equipped for the artificial drying of short grass. In Herefordshire special attention will be given to the production of seed of pedigree grasses and clovers on a commercial scale.

From Herefordshire the tour proceeds towards Aberystwyth, passing through typical West of England lowland country, into the hills of Wales. Delegates will see the transition from lowland to various grades of unimproved open hill grassland.

The map "Grasslands of Wales," reprinted from the book "A Survey of the Agricultural and Waste Lands of Wales," (Faber and Faber), will be made available at this point to assist delegates in a clearer understanding of the different ecological groups passed over.

On Wednesday, July 14, the tour proceeds to the Cahn Hill Improvement Scheme where large scale improvement of hill land is being carried out. At this point, all Congress participants, irrespective of the option chosen, will meet, and it should be particularly noted that this day presents the only opportunity to view this work in the course of the tour.

After the completion of the paper-reading sessions, the visits to the Welsh Plant Breeding Station, and to other local centres around Aberystwyth, the tour proceeds through country typical of central Wales, to Shrewsbury, to join the night sleeping train to Newcastle. Two days are spent in Northumberland visiting centres of grassland interest, including the experimental station at Cockle Park. Motor coaches will carry delegates to Edinburgh, visits to selected farms being made *en route*. For Thursday, July 22, a comprehensive tour will be made into the Trossachs district, which will give members the opportunity to see parts of the southern Highlands of Scotland. Members participating in options 3 and 4 of the tours will disperse in Edinburgh on Friday, July 23.

Colleges and other establishments for experiment and instruction in grassland to be visited include the following :—

University of Oxford.
Rothamsted Experimental Station.
Northampton Institute of Agriculture, Moulton, Northants.
Royal Agricultural College, Cirencester.
University College of Wales, Aberystwyth.
Imperial Bureau for Herbage Plants, Aberystwyth.
Armstrong College, Newcastle-on-Tyne.
Edinburgh and East of Scotland College of Agriculture.
Scottish Society for Research in Plant Breeding.

Special addresses will be given on certain evenings during the course of the tour, when matters of general interest emanating from the tours will be dealt with. Preliminary details of these evening discussions will be found in a later part of this section. During the tour further details will be provided in the form of guide books, maps and other literature which will be distributed at the commencement of the tour.

DETAILS AND COSTS OF TOURS.

All quotations are necessarily approximate ; the final figures will not differ much from those quoted below. The options 2, 3 and 4, stated below, commence with evening meal on the first day and end with breakfast on the last day.

Option 1. Aberystwyth only, paper-reading sessions and local tours. Intending participants will be expected to pay the Congress fee (see p. 179) and to find their own accommodation. A list of approved hotels, hostels, etc., in Aberystwyth and neighbourhood, can be obtained from the Joint Secretaries.
Duration, July 13 to 19.

Option 2. Assemble at Oxford, proceed to Aberystwyth through centres of grassland interest, as outlined in itinerary, and participate in sessions (Congress fee payable) and local tours.
Duration, July 8–19.
Cost per head : £11, to cover all charges for accommodation, in Colleges where possible, transport, gratuities, etc. Accommodation can be provided in hotels throughout at £13 per head.

Option 3. Assemble at Aberystwyth, attend paper-reading sessions (Congress fee payable) and local tours, proceed to Newcastle and Edinburgh, where disperse.
Duration, July 13–23.
Cost per head : £11, to cover all charges for accommodation, in Colleges where possible, transport, gratuities, etc., Accommodation can be provided in hotels throughout at £13 per head.

Option 4. The complete tour.
Assemble at Oxford, proceed to Aberystwyth, attend paper-reading sessions (Congress fee payable) and local tours, and proceed thence to Edinburgh.
Duration, July 8–23.
Cost per head : £18, to cover all accommodation, in Colleges where possible, transport, gratuities, etc. Accommodation can be provided in hotels throughout at £21 per head.

Alternative rates can be quoted for those intending to provide for their own transport on tour.
It is hoped that hospitality will be provided for meals on tour, other than those quoted for above, but occasions may arise when it may be necessary to make a small charge for midday and afternoon meals.

Railway Fares.

London–Oxford : Single fare, first-class 13s. 3d., third-class 8s.0d.
Edinburgh–London : Single fare, first-class 82s. 6d., third-class 49s. 6d.
Port of Leith (Edinburgh) is suitable for Scandinavian departures.

Transport Arrangements.

Oxford to Aberystwyth, by motor coach.
Aberystwyth (local tours), by motor coach.
Aberystwyth to Shrewsbury, by motor coach.
Shrewsbury to Newcastle by overnight train (sleeping coaches as far as possible.)
Newcastle to Edinburgh and Trossachs tour, by motor coach.

Owing to the fact that a greater part of the travelling will be done by motor coach, it is absolutely essential that baggage should be confined to one suit-case per person (average size 26 × 14 × 6·5 inches). It has been arranged that special dress need not be worn at evening entertainments.

In connexion with all local tours around Aberystwyth, there may be a small additional charge to cover transport.

Special attention is drawn to the four options outlined above, and particularly to the choice between accommodation in Colleges and University Hostels, and in hotels throughout. The precise option desired should be clearly indicated in the appropriate place on the form of acceptance.

CONGRESS FEE.

In addition to the tour charges outlined above, there will be a Congress fee of two pounds (sterling), which will entitle members to attend all sessions and to receive the printed transactions, including all abstracts in advance of the Congress meetings, and any other incidental matter relating to the Congress.

All participants, except wives, will be asked to deposit the Congress fee of two pounds sterling on a date to be specified later. Only those who have made this

deposit can be accommodated at the Congress. The Congress fee for wives accompanying members will be one pound sterling, payable in advance ; this will admit to full membership of the Congress, but will not entitle such members to receive a copy of the transactions.

Special arrangements regarding Congress fee have been made for the members of the International Grassland Congress Association. Particulars may be obtained from the Organizer, Dr. R. Geith, Institut für Landwirtschaftliche Betriebslehre der Universität, Leipzig, Johannisallee 23, Germany.

All payments in connexion with the Congress and the excursions must be made in sterling on a date which will be specified.

Paper-reading Sessions.

As already stated in the Preliminary Itinerary, there will be three plenary sessions and two sectionalized sessions, to be held at Aberystwyth.

The British Executive Committee of the Congress will invite members to present papers at the Plenary Sessions. The Committee will also invite other members to give the opening papers to the various sections. These papers will be published in the Report, together with the other sectional papers. The cost of this Report will be covered by the Congress fee.

Any member of the Congress may offer a paper for presentation at a Sectionalized Session, but, except in special circumstances, no paper will be accepted by the Executive Committee unless accompanied by an assurance that the writer intends to present it in person. As the number of papers presented for the sectional meetings will be considerable, the Executive Committee reserves the right to make a selection. Papers conforming to the sectional divisions will receive preference.

Sections of the Congress.

For the morning and afternoon sessions on July 16, the Congress will divide into six sections, to consider the following aspects of the grassland problem :—

(1) Ecology (including surveys), pasture and range management (including erosion control).
(2) Seeds mixtures (including lucerne for grazing) ; legumes for use in poor pastures.
(3) Plant breeding, genetics, and seed production.
(4) Manures and fertilizers.
(5) Nutritive value of pastures ; fodder conservation.
(6) Grassland economics.

Each section will have a President and two Vice-Presidents, to be appointed later.

Instructions regarding papers.

Plenary and opening sectional papers must not exceed 3,000 words and sectional papers must not exceed 2,000 words.

Papers should contain full reports of the author's conclusions, but technical and local details more suitable for the usual scientific journals should be omitted. Tables and diagrams should only be included if absolutely necessary. Facilities will be available at the Congress for exhibiting previously prepared tables.

Manuscripts should be typed on one side of the paper only, and should be carefully revised before being dispatched, as it may be impossible to submit proofs to authors.

Abstracts (not more than 300 words) of all papers must be in the hands of the Joint Secretaries as soon as possible and in all events not later than **February 1, 1937.**

The full text of the Plenary and opening sectional papers should be received by the Joint Secretaries before **April 1, 1937,** and all other papers before **June 1, 1937.**

REPORT OF CONGRESS.

The Joint Secretaries hope to publish in the spring of 1937 a volume containing abstracts of every paper in English and German, and possibly in a third language, if circumstances make this necessary. All Plenary Papers will be available in printed form for distribution before or at the Congress. The complete Report containing Plenary Papers, Sectional Papers and Discussions will be published later in 1937.

EVENING DISCOURSES.

It has been arranged that certain evening talks will be given during the tour, with the object of introducing participants to the types of grassland and pasture management to be seen on the following days. Arrangements are only tentative at this stage.

Place.	*Date.*	*Speaker.*
Oxford	July 9 ..	Professor J. A. Scott Watson.
Cirencester ..	July 12 ..	A. W. Ling.
		Professor R. G. Stapledon.
Aberystwyth ..	July 15 ..	Professor R. G. Stapledon. (Presidential address.)
Newcastle	July 19 ..	Professor J. A. Hanley.
Newcastle	July 20 ..	Professor J. A. Hanley.
		Dr. E. Wyllie Fenton.

EXHIBITIONS AND DEMONSTRATIONS.

The Institute for Research in Agricultural Engineering, Oxford, is arranging a demonstration of grassland implements on July 9.

Facilities will be available for the exhibition of maps, diagrams, photographs, etc., at Aberystwyth. Persons wishing to exhibit should communicate with the Joint Secretaries as soon as possible. Exhibits may be brought or sent to Aberystwyth, but at the expense and risk of the owners.

NON-PARTICIPATING MEMBERS OF CONGRESS.

Persons and institutions who wish to receive a copy of the Report without attending the Congress, may join the Congress and pay the Congress fee of two pounds sterling as non-participating members. Their names will appear in a special list appended to the list of delegates to be published for the meetings.

ZÜRICH, 1937.

The Eighth International Seed Testing Congress is to be held in Zürich, Switzerland, from June 29 to July 4, 1937.

MOSCOW, 1937.

The Seventh International Congress of Genetics which was to have been held in Moscow in 1937 has been cancelled. Various reasons for this action are given in *Science*, Vol. 84, No. 2190, pp. 553–4, 1936.

ANNOTATIONS

GREAT BRITAIN. (410)

Bulletin on Seed Production.

Thanks to the excellent collaboration of the correspondents of the Herbage Bureau, the Bulletin on the technique used in the production of seed of herbage and forage crops is now practically complete. Many recognized authorities in all parts of the world have kindly placed articles on the more important crops at the disposal of the Bureau for publication in the second part of the Bulletin. The replies to the first questionnaire have been very numerous, covering as they do a wide range of crops and climatic conditions, and the tabulated section compiled from the replies should be valuable.

Several interesting articles are being prepared for the fourth section of the Bulletin. The Editor now hopes to be able to add a sixth section to cover the geographical distribution of seed production areas in various representative countries. Articles have already been received from U.S.A. and Canada, and other countries at present under consideration include Great Britain, Australia, New Zealand, South Africa, and India. The Bureau would also like to be in a position to prepare a similar article as regards the geographical distribution of seed production areas in Europe, and will also attempt to obtain information from the Soviet Union. Any correspondent who can supply information, maps, acreages, etc., is invited to write to the Bureau immediately, in order that no time may be lost in preparing this Section.

All persons, Institutes, and Departments which have not yet replied to the first and second questionnaires in Circular No. 2/1936 are requested to do so immediately, in order that their opinions and experiences may be recorded in this Bulletin.

To those who have already sent articles and information, the Editor extends his very sincere thanks. It is hoped that the Bulletin will be ready early in 1937. —R.O.W.

Bulletin on Soil Erosion and its Control.

The Herbage Bureau is considering the preparation, in collaboration with the Imperial Bureau of Soil Science (Harpenden), of an exhaustive bulletin on Erosion, and would greatly value assistance in the collection of relevant material from all countries. The bulletin is to cover every aspect of the subject, including not only pedological, ecological, and climatic problems, but also the influence already exerted by erosion on human society and its probable influence on the future of civilization.

This may involve some departure from the Bureaux' usual policy of avoiding controversial matters in their publication, since consideration will have to be given in some cases to the interactions of erosion and politics. In view of the magnitude of the erosion menace and the fact that in many countries success or failure in meeting it may depend on government action and the active co-operation between town and country, any account omitting political and social questions would give a false impression of the present state of affairs and of the gravity and complexity of the issues involved.

Much, but not all, of the information required for this bulletin can be obtained from published works in libraries in Great Britain. Help is desired to ensure that nothing is overlooked, and also to supplement published material with any personal information which may be available. The kind of assistance requested includes any or all of the following :

(1) Reprints of papers, copies of circulars, memoranda or departmental correspondence dealing with erosion (with a note if anything is confidential).

(2) Copies of legislation, proposed or in force.

(3) Soil and vegetation maps, showing main eroding areas.

(4) Appropriate photographs and/or diagrams.

(5) Historical data, present extent and rate of erosion.

(6) Information on preventive measures, whether these are undertaken or supervised by one or more departments (e.g. agriculture, forestry), with or without inter-departmental co-operation. To what extent is erosion control left to individual enterprise? Does the State (or other body) subsidize control measures, and if so, how?

(7) Any particular influence of national life on soil erosion or vice versa (e.g. overstocking, religious beliefs, population movements, national policies, vested interests, diseases, and pests, etc.) on which special emphasis should be laid.

(8) Any special information.

It is felt that a comprehensive bulletin bringing together the available information on this world-wide problem would be opportune and welcome in every country threatened with erosion, and it is considered that the Bureaux, with the co-operation of their correspondents, are in a favoured position to undertake its preparation. —R.O.W.

GERMANY. (43)

Bavarian Seed Breeding Institute, Weihenstephan.

The Bayerische Landessaatzuchtanstalt Weihenstephan [The Bavarian Seed Breeding Institute, Weihenstephan] was founded by the State in 1902. An account is given in *Prakt. Bl. Pflanzenb.* 14. 35–90. 1936, of its development and activities to date, and of the work in progress and contemplated. A large proportion of the Institute's work relates to the study and breeding of forage and herbage crops.

The estate lies at an altitude of 465 to 470 metres in a fairly severe climate, average rainfall 660 mm., of which 443 mm. falls in the months April to September.

Field beans. There has been bred by selection a strain which is more capable of thriving under local climatic conditions than other varieties, namely, the Weihenstephan Freyabohne. Attempts to improve this by hybridization have not proved entirely satisfactory, and it is concluded that medium-sized grain and medium early ripening are of necessity imposed by the local climate. Crosses of 16 of the Institute's own bred strains with 12 varieties from other places have as yet led to no very definite results, nor has success in the breeding of a winterhardy field bean yet been attained. A large number of strains, varieties, and crosses are at present incorporated in trials.

Soybeans. The black-seeded forms have proved best under local conditions. Hybridization with a view to the obtaining of acclimatized strains has been begun. In addition to variety trials, an experiment to test the effect of length of day upon soya bean varieties is in progress.

Field peas. Breeding is confined for the present to *Pisum arvense*. It has not yet been found possible to combine heavy green weight with heavy seed yield. Original selection breeding started from various native varieties and excluded by degrees the small-grained forms, which had less vigorous early development and were more susceptible to disease and animal injury than large-seeded forms. Considerable improvement was obtained through crossing with *Pisum sativum* (the Mahndorf Victoria pea). Crosses of different field pea varieties were less successful. A large number of trials are in progress for the testing principally of green weight productivity, secondly of seed yield.

Lupins. Trials include those of sweet and bitter lupins. Selections are being made from *Lupinus micranthus*.

Vetch. Green weight, as in the case of the field peas, is the most important objective in breeding. Even more than in the case of the peas do heavy green weight and large seed yield appear to be incompatible. Selection and hybridization have both proved successful. Some former bred strains, notably a selection of *Vicia pannonica*, are already in use ; a new one is just being tested with a view to certification by the Reichsnährstand.

Clovers. In the breeding of *Trifolium pratense* it is endeavoured to produce (*a*) a productive one-year ley plant, (*b*) a perennial suitable for long duration leys and permanent stands, (*c*) a form resistant to clover rot. Experiments begun in 1912 to test inheritance of the yellow and violet seed colour and the white flower colour have demonstrated that the maintenance of these characters is possible ; there are already strains which inherit the yellow and violet seed colour and the white flower colour almost to 100 per cent. The white flower colour is correlated to the yellow seed colour.

The breeding of *Trifolium hybridum*, *T. repens*, *Lotus corniculatus*, and *L. uliginosus* for the breeding of strains adapted for long duration leys and for permanent grassland is in progress.

Lucerne. Crosses of *Medicago sativa* and *M. falcata* are designed to produce winterhardy, perennial, and less exacting forms. A search is being made for single plants and strains of good seed producing capacity, with a view to testing the heritable nature of this character.

Grasses. Thirteen species, including 838 bred strains with approximately 100,000 individual plants, comprise the subjects of breeding. The annual production of elite seed has increased in Bavaria from 2·5 dz. in 1920 to 2,300 dz. in 1928. The following are the objectives of work in progress at present : in *Avena pratensis*, the production of forms with firmly closed pales ; in *Phalaris arundinacea* and *Alopecurus* forms with evenly ripening seed ; in *Poa pratensis*, *Festuca pratensis* and *Agrostis alba* strains resistant to rust ; a pasture form of *Dactylis glomerata* ; through the hybridization of *Lolium perenne* × *L. italicum* the combination of the persistence and winterhardiness of the former with the bulk of the latter ; forms resistant to snow mould.

Seed production. The seed production of grasses and clovers in Bavaria is promoted and encouraged.

In connexion with the Government scheme for the testing, registration, and protection of plant varieties (see *Herb. Abstr.* 6. 31. 1936), 149 grass varieties and 127 varieties of leguminous plants are under observation. A brief list of the principal characters for which these plants are studied is presented.

Cytological studies of *Dactylis glomerata*, *Avena pubescens*, *Briza media*, and other grasses are in progress in the Botanical Laboratory ; and there is a Chemical Laboratory for the determination of mineral content, etc., in crop plants.

The two Government Experiment Farms of Osterseeon (97 hectares, altitude 560 m., heavy rainfall) and Strassmoos (83 hectares, part lowlands, part hill, low rainfall), were taken over by the Institute in 1925, and, while they are run as model farms for educational purposes, at the same time they serve the Institute in affording opportunity for experimentation and for the testing of bred strains under ordinary agricultural conditions.

In addition to the experiments in progress at Weihenstephan and on the above-named model farms, a large number of experiments are conducted on many different farms and estates (53 in 1936) in all parts of Bavaria, and approximately 400 variety trials per year are carried out in 80 to 90 different localities.

In the account of the Institute's activities there is included a brief review of the plant breeding accomplished since 1903 by private breeders, associations, etc., in the different parts of Bavaria.—G.M.R.

CZECHOSLOVAKIA. (437)

Union of Agricultural Experiment Stations in Czechoslovakia.

The Forage Crop Commission held its meeting on October 7 at Brno. Several propositions were discussed and a sub-committee was formed for the study of and experiments on pasture-forests. (*Zeměd. pokrok.* 3. 271–2. 1936.)—F.Ch.

NORWAY. (483.4)

The Pasture Experiment Station, Apelsvol, Norway.

A brief note, illustrated by photographs, of the activities of the Apelsvol Experiment Station is given in *Ernähr. Pfl.* 32. 309. 1936. It was instituted by the Selskapet for Norges Vel in 1930, is situated on humus, loamy moraine soil, relatively poor in phosphorus and potassium, near Gjøvik in the Province of Opland. Pasture experiments, under the direction of Dr. Bjarne Sakshaug, are concerned with manurial treatment of various kinds, yield trials relating to various herbage plants grown singly and in mixtures and also under various manurial conditions, chemical and botanical analyses, trials of different cultural methods, and the seed breeding of *Trifolium repens* and *Poa pratensis*.—G.M.R.

SWEDEN. (485)

Jubilee of the Swedish Seed Association.

On the occasion of the Jubilee of the Swedish Seed Association on August 11, Professor H. Nilsson-Ehle gave an address on the activities of the Association during the fifty years of its existence and referred to the work to be undertaken in the future (*Landtmannen Svenskt Land.* 20, 777, 778. 1936).

As regards meadow plants it is of importance to ascertain by means of trials which are the best local strains and subsequently to improve them further. In this work the branches of the Association play a very special part. There are now available new, valuable species of timothy, meadow fescue, and other hay grasses for different districts up to Upper Norrland. Good progress has also been made with the breeding of varieties of red clover. The Association is also endeavouring to render lucerne better able to withstand the Swedish climate; it is of great importance that seed of this species can be produced in Sweden.

With reference to pasture plants a State grant has been received for the establishment of a new breeding department. According to the trials conducted by the Association there are distinct differences between various strains of white clover as

regards the capacity to spread and drought resistance. With pasture grasses it is of the greatest importance to produce strains which tiller abundantly and rapidly and of such a growth that they do not suppress the clover. Leafiness also plays a great part, particularly in smooth-stalked meadow-grass.—R.P.J.

Svalöf Plant Breeding Station.

A good idea of the scope of the work at this Swedish Station can be obtained in the English edition of the little booklet, entitled " The Swedish Seed Association, Svalöf. A brief description for the use of visitors," published in Lund, 1936.

The booklet is divided into the following sections :

1. Organization and finance.
2. The marketing of the new varieties.
3. Breeding (methods, field technique, laboratories).
4. Scientific activities. The Genetics Institution.
5. Problems and results in the different species (winter wheat, summer wheat, oats, barley, peas, and vetches, root crops, potatoes forage plants).
6. The Branch Station.—R.O.W.

SWITZERLAND. (494)

Institute of Agricultural Chemistry, Liebefeld, Bern.

A report on the work of the Institute of Agricultural Chemistry, Liebefeld, Bern, for 1935 is published by the Director, Dr. E. Truninger, in *Landw. Jb. Schweiz*, 50. 545–68. 1936.

The number of grass and hay samples received for analysis was 108.

Pot trials included one designed to test the effect of calcium, in different forms, upon the calcium and potassium content of *Trifolium pratense*, *Dactylis glomerata*, and *Taraxacum officinale*, with and without liquid manure. Results are reported. In another pot trial a commercial calcium fertilizer was compared with ordinary ground Jura limestone in its effect upon lucerne. Results were equally good in both cases, whether the fertilizers were applied with the seed or as a top dressing.

Of the field trials the following are of interest. (1) An experiment, begun in 1933 and to be continued for several years, to ascertain the best time for applying liquid manure and farmyard manure to hay land. As in previous years, application in winter to land free of snow produced better effects than a dressing applied to snow-covered land or in spring. (2) Experiment, in progress for six years, to test the effects of one-sided and intensive dressing with liquid manure upon plant and animal. Special reference is made to the increased potassium content of the hay, which dressings of calcium have proved almost powerless to reduce. (3) Four trials on hay land, to test the effect of the nitrogen contained in " Nitrophosphate," the trials to last for three or four years, and results to be published later. (4) A three-year trial, concluded in 1935, of increasing doses of N applied to hay land on low moor soil. Results were practically negative. With 90 kg. calcium saltpetre per hectare the highest increase in yield was obtained, but this was in itself small, and with 120 kg. per hectare a diminution is recorded. *Trifolium pratense* disappeared almost entirely. (5) Trial to test the effect of three forms of calcium fertilizer upon the calcium content of hay. This trial, already in progress for five years and to be continued, indicates the efficacy, under the conditions in question, of readily soluble calcium saltpetre and of finely ground calcium carbonate, while in the form of gypsum the effect of calcium is practically *nil*. (6) Long duration manurial trial on hay land to compare the effect of one-sided and of balanced manuring upon the floristic and chemical composition of the vegetation and upon the chemical and physical condition

of the soil. The trial has been in progress for six years ; results cannot yet be computed. (7) A three-year manurial trial on acid land at an altitude of 1,100 m. Results have been published by Gutknecht in *Alpwirtschaftliche Monatsblätter*, May, 1936. (8) Trial of various phosphates (from 27 per cent to 40 per cent) on acid alpine pastures at 860 and 1,020 m. respectively. The experiment has only been in progress for one year and results are not yet available.

In connexion with 32 cases of animal disease associated with symptoms of depraved appetite, 58 samples of hay and herbage are being studied for mineral content, and conditions on the farms themselves are being investigated.—G.M.R.

CANADA. (71)

Ontario Agricultural Outlook, 1936.

This outlook report on agriculture in Ontario has been prepared by the Ontario Department of Agriculture co-operating with the Ontario Agricultural College, with the idea of giving assistance in the making of plans for the farm programme of 1936.

Recommendations are made for a number of the common forage crops. A chart on page 9 shows the percentage acreage under hay and clover (62·03), alfalfa (14·44), fodder corn (7·96), sweet clover (7·11), alsike (1·45), potatoes (3·66), turnips (2·41), sugar beets (0·94). The grain crops are also expressed in percentage form.

Seed production of the following crops is also discussed : red clover, alfalfa, timothy, alsike, sweet clover, and Canadian bluegrass (*Poa compressa*).—R.O.W.

UNITED STATES OF AMERICA. (73)

Soil Conservation Service.

The report of the Chief of the Soil Conservation Service (Mr. H. H. Bennett) to the Secretary of Agriculture for the fiscal year ended June 30, 1935, has been received. This publication contains brief mention of the numerous and widely varied activities of the Service. The importance of grass in the programme can be seen from Table 6, which shows that nearly one million pounds of grass seed are required for re-vegetation work in the Great Plains and Western States ; the most important species are *Agropyron spicatum* (100,000 lb.), *A. smithii* (163,000 lb.), and *A. scoparius* (210,000 lb.), followed by *Bouteloua gracilis*, *Poa sandbergii*, *Sporobolus airoides*, and *Hilaria jamesii*.

Further information regarding the use of different types of vegetation in controlling erosion appears in other parts of the report, particularly in the section from the Division of Agronomy and in the report of the research projects being studied at the Soil Erosion Experiment Stations, of which there are now thirteen. —R.O.W.

Carnegie Institution of Washington.

The Annual Report of the Chairman of the Division of Plant Biology is reprinted from the Year Book No. 34, for the year 1934–35, pages 191 to 221, issued December 13, 1935.

For a number of years a major effort of the Division of Plant Biology has been directed to the study of the influence of climatic environment on the life and development of living organisms, particularly of plants. These investigations have been carried out by different groups, or sections of the Division, which have attacked special features of the general problem, with different types of material, in different sections of Western United States, and with varying viewpoints and modes of

approach. The expression of climate in terms of vegetation and plant societies, the effects of changes in the climatic complex, the possible periodicities of climatic changes throughout long periods of time are of fundamental significance for an understanding of the forms of plant life as these exist to-day. Conclusions regarding these phenomena may well contribute to a solution of the more immediate problems of climate in its bearing on agriculture and forestry. Many of these investigations of necessity involve long periods of observation and experiment, and it is largely through cumulative experience under a diversity of conditions that results of value can be obtained. Several of these projects are now being brought to a definite focus in an effort to give expression to general conclusions.

The elaborate data of the extensive experiment undertaken by the late Dr. H. M. Hall to determine the extent to which taxonomic characters are modifiable through habitat factors (transplant experiments) were summarized during 1932 and the more general facts which thus become evident are being assembled for publication.

During the year an extended botanical exploration was carried out in Baja California by an expedition from the Desert Laboratory; this peninsula is characterized by extreme aridity, and many specimens of plants and types of vegetation are peculiar to it.

The penetration into the composition of any living organism or its processes has almost invariably revealed a vastly more complex situation than was expected at the outset. To this experience the study of the photosynthetic apparatus of plants is no exception. While the general outline of the chemistry of the green pigments, which are essential for photosynthesis, has been well established, the chemical structure and properties of the less obvious yellow pigments of leaves are still in progress of elucidation. The task has been greatly complicated by the fact that these latter components of the photosynthetic apparatus are far more numerous than was at first supposed, and the separation of the individuals has presented many difficulties. The necessity of contriving means of separating these individuals has, on the other hand, also led to a better understanding of their properties, so that this more intimate knowledge is serving as the basis for the development of theories concerning the role of these substances in the photosynthetic process.

Of particular interest to readers of this Series is the ecological report, on adaption and origin (F. E. Clements, F. L. Long, and E. V. Martin) and on climate, climax, and succession (F. E. Clements and E. S. Clements). Frequent reference is made to a number of Western grasses and to range problems in general.—R.O.W.

Minnesota Agricultural Experiment Station.

A review of the history and activities of this Station over a period of 50 years (1885–1935) has been published in Bulletin 319, May 1935. Reference is made to research on a number of forage crops, including alfalfa, sweet clover, soybeans, corn, *Phalaris arundinacea*, cereals, etc.—R.O.W.

CHILE. (83)

Agricultural Experiment Station, Santiago.

The report of the Agricultural Experiment Station of the National Agricultural Society (Sociedad Nacional de Agricultura) for the year 1935, reverting to the practice of 1924-29, appears this year in a separate volume. Genetical and experimental work has been continued under the direction of Señor Manuel Elgueta G. An exposition of the experimental technique employed at the Station is given at the beginning of the report (pp. 14–26).

Maize. Selection and reproduction are in progress.

Kidney beans. A trial of 36 varieties showed seven to be of value. The seed of most of these is being reproduced, and individuals are being studied. Manurial

trials at Santiago indicate that calcium and phosphorus are the elements most indispensable for bean growth. An experiment in the application of guano at San Fernando gave negative results.

Yield was generally low on account of abnormal weather in the summer.

Peas. The variety Hiljkema continued to give good results. Seeding rate 160 kg. per hectare, distance 40 cm., yield 39·87 qqm. per hectare. The grain was of excellent quality.

Soybeans. As a result of a trial of five varieties in four localities in 1934–35, and of 25 varieties in 1935–36, the selection of pure lines within three varieties, Ito San (which had already given good results previously), Illini and Dunfield, has been initiated, and the study of some other varieties is being continued. In variety trials at San Fernando and Santiago in 1935–36, the superiority of seed reproduced in Chile over newly-imported seed of the same variety emphasizes the value of acclimatization. The poor yields obtained from the " orginal " seed, which was, however, sown more heavily (50 kg. per hectare as compared with 40 kg. per hectare in the case of the Chilean-grown seed), is attributable to poor germination. An experiment to test different seeding rates and planting distances indicates 60 kg. per hectare sown 40 cm. apart to be advantageous in the case of Ito San and Manchu, although probably for practical farming a minimum distance of 60 cm. would be preferable on account of the difficulty of cultivating the closer rows. Manurial trials at Santiago and San Fernando are described : results in the latter place were negative, but at Santiago phosphates in combination with calcium were found, as in the case of kidney beans, to produce the best results.

A scheme was inaugurated in 1934 to popularize the growing of the soybean ; farmers entering into a contract with an industrial company which supplied seed and bought back the harvest. Under this scheme approximately 1,300 fields were sown down in 1934–35, and more than 12,000 qqm. harvested. The crop was relatively small, a fact which is attributed to the following reasons : (1) hardly any of the farmers sowed all the seed allotted to them ; (2) instructions were imperfectly followed, sowing being often too late or too deep and cultivation being neglected in many cases ; and (3) inoculation did not produce the results anticipated, apparently on account of insufficiently adapted cultures. The working of the contract system was entirely satisfactory, and the high percentage of oil contained in the soybeans harvested is notable, the average being approximately 18·5 per cent, in many cases more than 20 per cent, and in one as much as 22·6 per cent. The campaign for the extension of soybean cultivation was continued during 1935–36, both under the above-mentioned contract system and through the immediate activities of the Experiment Station (propaganda, advisory work, and distribution of seed). Abnormally bad weather during the summer has, unfortunately, resulted in a loss of at least 50 per cent of the sowings for the year ; and a yield of approximately 5,000 qqm. only is anticipated (at the date of going to press the figure was approximately 3,700 qqm.). Moisture content is, on account of early autumn rains, in many cases higher than the standard allowed. It is feared that the discouraging conditions of the year may lead to a set-back in the popularization of this crop.

Lentils. A two seasons' study of this crop has shown that it is difficult and uncertain to grow in the locality in which the Station is situated. From a special sowing 800 plants have been selected and studied for total grain weight, thousand grain weight, and average size of grain. From these plants 614 lines have been taken for reproduction in three different localities, one a coastal region in which the lentil grows very well. In some of these strains there are found grains with a mean diameter of 7·5 mm. The strains vary in regard to total grain weight and in colour and appearance of the grains. The progeny are to be studied in relation to the possibility of fixing these characters, and the relative resistance of the various lines to disease is also to be made a subject of investigation.

Lucerne. Several varieties and different families within the same varieties were studied for green yield in five successive cuts, hay yield, and ratio of stem to leaf. Results are shown in a table. A Moroccan variety proved superior to all the others in total yield and in vigour maintained from early in the spring right up to the fifth and last cut. An indigenous variety took the second place. It is noted that the study indicates the strains most valuable for hay : a search for pasture types might fundamentally alter the order of arrangement. Considerable differences, probably the results of selfing,are sometimes recorded between families within the same variety, but they are not so great as to suggest that it would not be comparatively easy to obtain pure lines.

A member of the Station's staff is at present in Europe studying research methods with a view to the utilization of certain legumes as forage plants. The reproduction and sale of selected seed, including that of kidney beans, continue. An herbarium of wild grasses and of weeds and a library have been inaugurated at the Station within the period under review. [For previous reports see *Herb. Rev.* 3. 45 and 205. 1935.].—G.M.R.

Chronica Botanica, the year-book of plant science, has been designed to bring together the research programmes of all laboratories, experimental stations, herbaria, botanic gardens, etc., to give a résumé every April of the professional and personal news of the past year and to promote co-operation between workers in the various branches of plant science in every possible way.

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